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M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

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IT seems that electric lighting for cars has found more favor in Europe than in this country, and experiments with the electric light have been made on a number of lines. On the Midland Railroad in England, and on several of the French and Swiss lines, the success of the electric light has been so great that the International Railroad Congress recommended that the experiments be continued in preference to those with gas. The systems used have been the storage battery; the dynamo run by belting and gearing from the car axle; and the dynamo run by an engine carried either in the baggage car or in a special car. Each of these systems has its advocates, and further experiments seem to be necessary to decide between them.

AN important engineering work now in progress, which has attracted thus far very little attention, is the Transandine Railroad in South America, which is an extension of the Argentine Pacific Line, and which will, when completed, connect the port of Buenos Ayres on the Atlantic with the Chilian port of Valparaiso on the Pacific Coast. The total length of the road when completed will be 870 miles, and of this 640 miles on the eastern end and 80 miles on the western are now in operation, leaving about 150 miles in construction. This section, however, includes the most difficult work of all, the crossing of the Andes. This crossing is made at the Cumbre Pass, the summit level of which is about 13,000 ft. above the sea, but the railroad will find its highest level at 10,450 ft. above the sea, where it will penetrate the mountain by a tunnel 3¼ miles in length. On this tunnel work is now in progress, while a considerable portion of the grading of the rest of the mountain section is finished.

It was originally intended to make an ordinary railroad across the mountains, but the expense threatened to be so great that it was finally decided to adopt the Abt rack-rail system for a considerable distance; this permits the use of grades as high as 8 per cent., and not only decreases the cost, but allows the line to be made considerably shorter than it was by the original survey.

It may be noted that there will be on this line three different gauges. The Argentine section, from Buenos Ayres to Mendoza, is 5 ft. 6 in. gauge; the Chilian section from Valparaiso to Santa Rosa, is 4 ft. 8½ in., while the connecting section or mountain line is 1 meter gauge. Of course, should this line develop any considerable through traffic, these breaks of gauge will be found very inconvenient, and in that case they will doubtless after a time be made uniform.

The contractors for the mountain section are J. E. & M. Clark & Company, an English firm, and they have a large force at present employed. No date has yet been set for the completion of the line, but it is expected that trains will run through from the Atlantic to the Pacific some time in 1892.

NEW railroad construction for the nine months ending with September is reported at about 3,300 miles. A very large proportion of this is in the South, which seems at present to be the most promising field for work of this kind. As in the earlier months of the year, the greater part of the new construction is in comparatively short lines, mainly for local traffic. The present indications are that the total addition to our railroad system this year will be not far from 5,000 miles.

THE plan of putting an additional story or double-deck on the elevated railroads in New York, in order to increase their facilities for carrying passengers, is again brought to our attention by a correspondent. There is no doubt that more facilities are urgently needed now, and that the need will be very strikingly apparent when the great Exhibition in 1892 brings its additional crowds to the city. It does not seem possible that any new rapid-transit lines can be completed before that time, as the work of building would be necessarily slow, and in any case it will be a year at least before work could be begun on a new line in view of all the legal obstacles in the way.

The advantages urged in favor of this plan are that no new ground will be occupied, and that additional damages to the property along the lines of the roads will be very light. The trains could be at once doubled in number, and a great improvement in service could be secured by using one deck for fast through trains to carry passengers to the upper part of the city, and the other exclusively for way trains making all the stops. To adopt this plan it would not be necessary, probably, to replace the present structures at first. The upper deck could be erected without interfering with the old lines, and in case it should be decided to rebuild, all of the trains could be run on the new tracks for a time. New posts or supports would, of course, be necessary for the new tracks, but those might be so built and proportioned that the weight of the old trusses could be transferred to them after they were finished.

It certainly seems that it would be an advantage to have the present structures of the elevated railroads replaced. While they are good of their kind, for the most part they are not equal in design or strength to the new Brooklyn lines, or to the Suburban Elevated line, in which the experience gained in the New York lines has been turned to good account. Our correspondent's plan is not worked out in detail, but the general idea is well worth consideration.

THE building of a tunnel under the Harlem River to replace the present bridge at Seventh Avenue—generally known as McComb's Dam Bridge—is recommended by the Commission of Engineers to whom the question was

referred. This bridge will need renewal in a short time, and after considering all the circumstances, the Commission believe that the tunnel will serve the public convenience better than a new bridge. The tunnel they recommend would be about 450 ft. long, having two large passages for carriages and a smaller one for foot-passengers. The approaches on either side of the river would be 1,800 ft. long, and would have a grade of 3 per cent. The total cost, including land, is estimated at about $2,000,000.

The bridge in question connects Seventh Avenue, which is the main drive northward from Central Park, with Jerome Avenue on the north side of the river, and the travel over it is very heavy, as it forms part of the principal pleasure drive of the city. A new crossing of the river at that point is urgently needed, and either a bridge or a tunnel must be built in a short time. The tunnel would present the advantage of being free from interruption by the opening of the draw, which is a constant annoyance with the present bridge, while this obstruction will increase very much with the completion of the Harlem River improvement, when it is expected that the number of vessels using the river will be very much increased.

THE law prohibiting the use of car stoves in the State of New York, which takes effect this winter, will, it appears, be generally complied with. The only Company of any importance which resists its enforcement is the New York, New Haven & Hartford, and against this Company a suit has been brought by the Attorney-General of the State. The Railroad Commissioners recently granted an extension of time to the Central New England & Western Company, that Company having shown that it has made arrangements to introduce steam heating on its trains, and has contracted for the necessary material. A short extension was also granted by the Commission to the Pullman Company, that Company having also shown that it is equipping its cars as rapidly as possible.

THERE have been several projects for a railroad connection between England and India more or less feasible, those most favored heretofore having been for a line through Syria and the Euphrates Valley. The latest is on an entirely new line and is said to have been submitted by no less an authority than Sir Edward Watkin to the Secretary of State for India. His plan is for a line starting from Calais—using the Channel tunnel should it be built hereafter—and running thence over existing lines, with some necessary additions, to Gibraltar. Here a steam ferry would be used to carry trains across the Straits to Tangiers, whence the road would run eastward along the north coast of Africa through Egypt, Arabia, and Persia following the eastern shore of the Persian Gulf to Kurrachee, where it would join the Indian Railroad System. This plan is said to have the approval of prominent engineers and capitalists.

THE Russians thoroughly appreciate the commercial and political importance of their Trans-Caspian Railroad and are seeking to extend its connections in all directions. A concession has recently been obtained from the Persian Government for a line from Askabad southward to Meshed in Persia. The latter town is not only an important commercial point, being the center of trade for all of Northern Persia, but is also a position from which extensions of the road could be pushed in several directions. A line could be carried from Meshed through the valley of the Heri-Rud to Herat on a better line than could be obtained by working from Merv southward. In the other direction a line could be carried across the mountains to Ispahan, or, if desired, to some point on the Persian Gulf; in any event the branch would put the Russians in a position to control a large part of the trade of Persia, and also to extend the political influence which they have already acquired in that country.

A NEW and somewhat unexpected traffic is coming to the Russian Transcaspian Railroad. This is a trade with India, which native merchants have begun to carry on by means of caravans which travel from Northern India by way of Candahar to Merv, where their freight is transferred to the railroad. This has been a commercial route from time immemorial, and its present new development may have important results, both economical and political.

Since the opening of this road its commercial business has increased so much that considerable additions to the Russian fleet on the Caspian Sea have been found necessary, and a number of new steamers are now under construction for that trade.

THE International Marine Conference, which began its sessions in Washington, October 16, has an extensive programme before it; too extensive, in fact, to be fully acted upon during the limited time allowed it. All the leading maritime nations of the world are represented, however, and the conference will do an excellent work if it succeeds in establishing a uniform code of rules and signals to be used at sea. This, in fact, is its main object, and it is one which has long been desired.

THE Legislature of Pennsylvania at its last session authorized the appointment of a Commission to inquire into and report upon the possibility of constructing a ship canal to connect Lake Erie with the Upper Ohio River. The Commissioners, as appointed by the Governor, are John A. Wood and Reuben Miller, Pittsburgh; W. S. Shellenberger, Rochester; John M. Goodwin, Sharpsville; Eben Brewer, Erie. This Commission was to meet for organization in Pittsburgh, October 24. Its work will be preliminary, and is intended to provide information upon which the Legislature can base future action.

ENGINEERING IN NAVAL WARFARE.

THE stupendous changes which have been and are still being made in the construction of modern war-ships, should and must direct public attention to the kind of knowledge and skill which is now most essential in the conduct of our naval affairs to make that arm of our service equal or superior to that of other nations, and to secure success and victory in case of war. The belligerent propensities of the civilized portions of mankind are now held under so much restraint, and inventive and constructive faculties are so freely and so actively exercised, that the means devised for attack and defense are seldom subjected to adequate tests in actual warfare before they are supplanted by some new device or discovery more effective and destructive than those were which have preceded it. It is not surprising, then, that there should be great differences of opinion with reference to the value and efficiency in actual war of many of the diverse kinds of ships, armor,

guns, and machinery, which every civilized nation in the world is now engaged in constructing. Fortunately there has thus far been no adequate opportunity of testing the powers of offense or defense of the most modern war-ships and their armament. Nearly all other machinery when it is completed is put into the service for which it is intended: its efficiency is thus tested, its defects are made apparent, and are remedied as the light of experience may indicate is needed. With the mechanism of naval warfare it is different. All that can be done is to reason on past experience with quite different appliances, and seek for information by means of tests, trials, and experiments, and occasionally, as the boys say, "fighting in fun."

There are certain facts, however, which are made apparent by sham warfare, and the exercise of that kind of prescience which comes from knowledge and experience in designing, constructing, and using engineering appliances of almost any kind. One of these facts is that a modern war-ship and its armament is essentially a creation of mechanical engineering.

The conception and design of the ship, its armor, engines, guns, and machinery are a consequence of the exercise of a knowledge of the principles of their construction, the properties of the materials used, and the multifarious processes, arts, and appliances which must be employed in their manufacture. When completed it is a great aggregation of mechanism, a thorough knowledge of which, with skill in its use, are essential to the successful operation of the ship. When sailing vessels were used, the most important personage on board was the officer who directed the navigation. He had a thorough knowledge of his calling, and had the best opportunities of becoming acquainted with the rigging and other appliances for sailing his ship. The introduction of steam, however, changed all this. The speed of vessels was much increased thereby, and by means of which commanders and navigators are usually quite ignorant. The offensive and defensive power of a ship is now largely, if not chiefly, dependent upon its means of propulsion. As Commodore Ramsay is reported in one of the daily papers to have said recently:

> Speed is one of the chief requisites in a war-vessel. In modern naval warfare a slow man-of-war is efficient in comparatively few engagements. A vessel with fewer guns, which can move about with great rapidity and get in position, has an advantage over a heavily armed and well-protected vessel which does not possess great speed.
>
> If there are two cruisers of exactly the same dimensions, the same armament, the same crew, whose officers are equally efficient, and one can sail a knot an hour faster than the other, she will whip the slower ship just as sure as they have an engagement.

Much light is thrown on the actual condition of affairs in the different navies of the world by a report recently published of the manœuvers of the British, Italian, and Spanish navies. Of the British manœuvers it is said: "From all sides came complaints of defective machinery. The squadrons were constantly impeded in their speed and in their movements by 'lame ducks' needing repairs." The best speed one of the ships could make was 8 knots, others steamed at 9 knots with difficulty, four of them had hard work to keep up 10 knots, the *Mersey* could only make 14½, and had to slow down to clean tubes; the *Mohawk* class failed in boilers and boiler tubes, the *Raccoon* practically broke down, and the *Serpent* was almost constantly under repairs. Most of the torpedo-boats gave trouble, and nearly all the fast cruisers failed to steam up to their nominal speed.

After the manœuvers of the Italian Navy, it was said in a newspaper that seven of the ships would each need 12 days' repairs, and five others from 10 to 30 days, and 13 torpedo-boats 10 days each.

In the Spanish torpedo-boat manœuvers, the crown sheet of the boiler of one boat collapsed and killed four men, another which came to her relief damaged her machinery, a third bent her propeller blade, and a fourth had a boiler disabled.

A record like this made in times of peace shows how dependent the efficiency of a navy is on the machinery of its ships; or, as Lieutenant Stanton, of the United States Navy, has written: "In these days of mastless armored ships, of coal and countless mechanisms, torpedoes, electricity, and rifled guns, a dozen shops and factories contribute to the outfit of a single ship, and a misfitting valve may cause disaster."

It is of the utmost importance, then, not only that a war-ship should be fast, for, as Commodore Ramsay says, "a fast ship always possesses high offensive power because she is fast, and if she cannot fight successfully she can get away;" but a war-ship must also have the merit of not breaking down in service. In actual war probably most of the ships which were disabled in the British, Italian, and Spanish manœuvers would have been captured by the enemy. In a battle the most skillful navigator or the greatest master of naval strategy could not save a ship if the valve-gear broke down or a tube collapsed. Engines should be designed not only to give the required speed on a trial trip, but so as to be reliable while in service. Doubtful, untried, and hazardous forms of construction may expose a ship and its crew to danger, which will be fatal to both. The ability to discriminate among those forms of construction which are safe and can be depended on to do efficient service, under all circumstances, comes only with a thorough knowledge of the subject, ripe experience, and a sound judgment, and unless the designs of the machinery with which our war-ships are equipped are determined by officers with such qualifications, the history of our Navy will be the occasion of humiliation to all of us.

The inference to be drawn from these observations is, that the engineering department of our Navy is the most important branch of its service at present, and perhaps always will be.

For some reason, which is not easy to understand, there seems to be a distinct tendency in republican governments, which is averse to recognizing the value and importance of a thorough knowledge and experience on any subject which is difficult to comprehend fully. Such qualifications seem to excite a feeling of resentment in the democratic mind. There are evidences of this in the estimation in which the construction and engineering departments of our Navy are held by the average Congressman and others higher in authority. The type of man who holds the most exalted position in the mind of the ordinary politician is what is known as a "hustler," than whom none is more unfit for the duty of designing or judging of designs of ships, engines, guns, or any other mechanism. It is conceivable that a "hustler" might command or fight a ship successfully, but could do naught else but blunder if intrusted with its design. If we should have a foreign war—and we are not entirely free from that danger—it will be possible to find men to navigate and fight our ships, if they are planned and built as they should be, but neither

skill, courage, knowledge, nor "hustling" will avail if our Navy is composed of vessels which are slow, whose engines break down, and whose boilers will not make steam. In constructing our Navy, competent engineers are imperatively needed, and no knowledge of naval tactics or navigation will avail during hostilities if the engines are in incompetent hands. In other words, naval warfare has become an engineering contest, and the branch of the service which designs and controls the mechanism of our ships should be honored as much and paid as well as any other in the Navy. The ability to design machinery does not come by nature; although much depends upon natural aptitude, without experience, and a great deal of it, no amount of knowledge or talent will be sufficient. Thousands of matters of detail must be mastered, there must be fertility of invention in adapting means to ends, unlimited resources for overcoming difficulties, many of which have become matters of tradition; safe conservatism which keeps well within the bounds of certainty and yet avails itself of all the latest improvements; a semblance of omniscience which gathers in all existing information relating to a subject and then deduces infallible conclusions therefrom; a kind of mental gravitation to the safe side of doubtful questions, with a receptive faculty which keeps the doors of the mind wide open to take in all new ideas that are valuable—these are the qualifications of a superior mind, and in that branch of our naval service where they are so essential, should be honored by rank and authority.

IRRIGATION.

A STRIKING incident of the Congress of Engineers on the Utilization of Waters, which was held recently in Paris, was an address made by the Mandarin Tcheng-Ki-Tong. "Your western civilization," said the representative of China, "is admirable in many respects; we of the Far East admit your skill in construction; you can build hydraulic machinery of the most efficient kind; your pumps and other apparatus surpass anything that we have, and in controlling the flow of your rivers and building magnificent structures to cross them, you have the advantage of us—but in the real utilization of water for the purpose for which we in China believe that Nature intended it, your civilization has not yet reached the point to which ours attained 4,000 years ago."

With this introduction, the Chinese engineer proceeded to prove his assertion and really made out a very strong case in favor of his claim. In China from the earliest historical times there have existed very extensive works for the irrigation of the land, and the Chinese farmer many years ago ceased to depend upon the rain, or the uncertainties of the weather, for the prosperity of his crops. There the most apparently barren and useless land has been made to produce two or three crops per year, and the Government long ago realized the fact that upon the proper storage and distribution of the waters depended the real prosperity of the country.

It is true that in some portions of France, Spain and Italy systems of irrigation have been in use for a number of years, but they do not approach either in completeness of design or execution to those which were carried out in China long before the Christian era—3,000 years, in fact, if the claim of the native historians be true.

From present indications, however, it seems probable that before many years the reproach which was thus cast upon western engineers will be removed by the action taken in this country. The settlers in Southern California early realized the fact that to make that section a productive one, irrigation must be employed, and the rainfall which was sufficient in quantity, but which did not come at the proper season of the year, could only be made to assist the soil in producing crops by some system of storage and distribution. The experiments made in scattered localities and on a small scale, proved so successful, that later arrangements were made for concerted action, and companies were organized with sufficient capital to divert the course of rivers, erect dams and storage reservoirs, and provide the necessary flumes and canals for distributing water on a large scale. In almost every case these have been successful and have encouraged the continuation of the work until it has become probable that in a few years nearly all the farmers of Southern California will depend wholly upon irrigation for their success.

The California example has been followed to some extent in the territories, where it was ascertained by careful experiments that the water furnished by the winter rains and the mountain snows would, if the supply was stored and equalized, be sufficient for the needs of cultivators throughout the year. Experiments made by enterprising pioneers in Montana, Idaho, Utah, Colorado, and Arizona have proved that large areas, which had been regarded as barren and desert country, could be made by irrigation to produce crops as great or even greater than are obtained from the fertile lands of the Mississippi Valley. The results in some cases have been extraordinary and have encouraged undertakings of a similar kind on a larger scale.

Under these circumstances a movement in favor of extending and regulating the systems of irrigation has sprung up on the Pacific Coast and in the Territories, which was strong enough last year to secure the appointment of a special committee by the United States Senate for the purpose of considering the whole subject, and recommending such action on the part of the Government as may seem to be necessary and judicious. The conformation of much of the so-called desert land of the West is such that to provide a proper supply of water for this purpose, extensive works will be needed, and it is uncertain whether individual or corporate enterprise will be able to carry out all of this in the proper way. At any rate, whether national aid is desirable—and this is certainly still an open question—some national regulation must be had in order to prevent confusion, litigation, and perhaps waste of resources. In many cases the storage reservoirs must be established in mountains at long distances from the points where the water is to be used, and litigation may easily rise between claimants for the sources of supply. Moreover, there are many legal points in relation to water-rights, and a definite system of irrigation law would seem to be one of the necessities of the situation before capital can be freely applied for this purpose.

It will be readily seen how, without proper regulation the ownership of water-rights and irrigating canals might be developed into a vexatious monopoly which would hold the farmers at its mercy and subject them to intolerable exactions. It will also be seen that in many cases a partial and unsystematic course of proceeding might prove wasteful and injurious, and would fail to develop the water resources of the country to the best advantage. The Senate Committee in its labors has had the assistance of experts

of wide experience, and something in the same direction, has been done by the Geological Survey—a work which is to be continued.

The State of Colorado, in which some of the earliest practical demonstrations of the possibilities of irrigation were made, has provided an excellent code of water laws, which has so far worked very well, and which may serve as a model for future legislation, either State or National.

The subject is one of great importance, and upon its proper treatment may be said to depend the future prosperity of a large section of the West, and the adaptation for agriculture of the greater part of the public lands which are still unsettled.

THE WORLD'S SHIPPING.

THE accompanying table, compiled from the *Universal Register*, gives the total number and tonnage of all the seagoing vessels in the world in 1888. The first, second, third, fourth, fifth, sixth, and seventh lines in each table show the number of vessels owned by Great Britain (including the colonies), the United States, Norway, Germany, France, Italy, and Spain, and the eighth line shows the total for the world, including all minor countries, as well as the seven named. No vessels under 100 tons are included in the list.

I.—STEAMERS.

	No. of Vessels.	Tonnage.	Av. Tonnage.
1. Great Britain	5,914	7,304,815	1,235
2. United States	425	516,251	1,215
3. Norway	329	185,399	564
4. Germany	640	726,044	1,134
5. France	490	740,325	1,511
6. Italy	201	284,369	1,415
7. Spain	380	398,733	1,048
8. The World	10,260	11,552,101	1,126

II.—SAILING VESSELS.

1. Great Britain	6,103	3,524,387	577
2. United States	3,148	1,401,924	445
3. Norway	2,929	1,270,865	434
4. Germany	1,292	683,794	530
5. France	920	244,621	266
6. Italy	1,461	562,532	317
7. Spain	574	139,048	242
8. The World	22,402	9,496,603	424

III.—TOTAL, STEAM AND SAIL.

1. Great Britain	12,017	10,829,202	901
2. United States	3,573	1,918,175	537
3. Norway	3,258	1,456,264	447
4. Germany	1,932	1,409,838	729
5. France	1,410	984,946	699
6. Italy	1,662	846,901	510
7. Spain	954	537,781	564
8. The World	32,662	21,048,704	644

No other nation than the seven named owns over 500,000 tons of shipping.

It will be seen that sailing vessels compose 68½ per cent. in number and 45 per cent. in tonnage of the world's seagoing fleet. Vessels for river or inland navigation are not included in the *Register*.

Great Britain owns 63¼ per cent. of the steam tonnage, 37 per cent. of the sail tonnage, and 51½ per cent. of the total tonnage. That country also, as will be seen from the table, owns the largest vessels, the average tonnage being the highest, except in steamers, where France and Italy show greater averages; but the number of steamers owned by those countries is small.

It may be noted that while there was during the year a slight increase—283,059 tons—in the total tonnage, the gain was entirely in steamers, the sail tonnage showing an actual decrease of 323,889 tons—that is, the tonnage of new sailing vessels built last year was considerably less than that destroyed by wreck or broken up from old age. This has been the case for several years past, and the process of substituting steamers for sailing vessels has been gradually going on all over the world.

There has also been going on a gradual increase in the average tonnage, which has in four years increased from 607 to 644 tons, a gain of 6 per cent. This is partly due to the increase in number of large steamers.

It is possible that this tendency to decline in sail tonnage may receive a check, for a time, at least, since there are at present a number of large sailing ships under construction in Europe, including several designed for carrying oil in bulk. In this country, also, there is a tendency to the building of large sailing vessels for the coasting trade.

What especially concerns us is the low position which the United States holds in the list as compared with Great Britain. With a very extensive coast line and great resources for building ships, our tonnage, both steam and sail, is really insignificant when compared with that country. This question has been the subject of much inquiry, and all sorts of plans have been proposed to improve this state of things. The true solution of the problem has not yet been reached, however, and should still be carefully sought.

It is a very important one, for every succeeding year increases the proof of the rule, laid down many years ago by a great economic writer, that "No nation ever has been, or ever will be truly great commercially, which does not carry its own freight in its own bottoms."

NEW PUBLICATIONS.

A MANUAL OF MACHINE CONSTRUCTION FOR ENGINEERS, DRAFTSMEN, AND MECHANICS: BY JOHN RICHARDS. Philadelphia; J. B. Lippincott & Company.

This book might be described as a volume of mechanical generalizations. In his preface the Author says that he "once supposed, and ventured to claim, that constructive processes, arrangement and proportion of machine parts could be made amenable to exact, or measurably exact rules. This opinion has been abandoned for a belief that special knowledge and experience must remain the greater part, and books, references and rules can deal only in a limited way with constructive engineering."

These remarks indicate the character of the book, which consists of a series of observations with reference to machine construction, followed by illustrations and data concerning its proportions. Thus, in the first chapter there is a description and illustration of a drill-press in which the reasons are very clearly set forth for the general arrangement of the different parts or organs of the machine. This is followed by short dissertations on the sectional forms of machine framing, standards, supports, ribs and fly-wheel rims, pulley spokes, bosses for screws and nuts, and, when the subject admits of it, tables of dimensions for such parts of different sizes.

In the second chapter bearings, shafts and spindles are treated in very much the same way. There is first a table of ingredients for alloys for machine bearings; then descriptions and illustrations are given of journal bearings

for wood framing, rigid bearings, heavy pedestal bearings, diagonal bearings, pivoted pedestal bearings, adjustable pivot bearings, suspension brackets, counter-shaft brackets, tapered bearings, spindle and Schiele bearings—a brief description, with a few suggestive observations and a table of the principle dimensions for such bearings of different sizes. Without treating these subjects exhaustively, it gives just the kind of information which a draftsman, mechanic or any designer of machinery often wants to get off-hand, without spending any time in wrestling with mathematical formulæ or deciphering the obscure English in which it seems to be the fashion now for technical writers to hide their ideas.

The following remarks on radial bearings is given as an example of the Author's clear treatment of a subject which is generally very imperfectly understood:

These bearings, with their surfaces moving at different velocities, are one of the worst things to contend with in construction, and are responsible for a great share of the difficulties in operating machines. It is ignorance or disregard of this principle that has led to a great waste of time and effort expended on rotary engines and rotary pumps.

The diagram, fig. 36, is drawn to illustrate the principle of radial bearings. It is an exaggeration of actual practice, but corresponds in operation to collars, end bearings and so on.

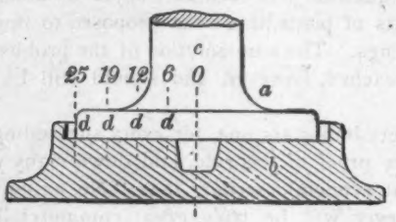


FIGURE 36.

The disk *a* is supposed to revolve on the seat *b*. If the disk *a* on the shaft *c* is 8 in. in diameter, the velocity at different distances from the center will be approximately as the figures on the lines *d*, varying from 0 to 25.

Now, supposing wear to take place, as the velocity or the distance moved, and that such wear—even one-thousandth part of an inch—will relieve pressure, it is easy to see that the pressure will not be distributed equally, but will begin at the center and increase there until the faces are destroyed. With this in view it is easy to understand how radial faces in pumps and engines cannot be kept steam or water-tight. The velocity being directly as the length of radius, it is obvious that thrust-bearings of all kinds, with radial faces, should consist of shallow collars in order to secure a more uniform velocity of the surfaces.

Modern thrust-bearings for propeller shafts are an example. Every attempt to receive this enormous pressure on faces with long radii, or wide faces, was a failure. End screws or points equally so, because of the small surface. The Schiele bearing being too large in diameter, and not understood in most cases, the natural result followed. The radius or depth of the collars was reduced to one-eighth part of the whole radius, and the number of collars increased, until the pressure on the aggregated surfaces fell within a practical working limit. This done, there has been no further difficulty in resisting a thrust equal to 5,000 or even 10,000 horse-power.

The same rule applies everywhere and in all cases; either the surfaces must have short radii or else they must conform to the curve of equal tangents shown in fig. 27, otherwise they are soon destroyed.

A study of this subject is commended to the inventors of rotary engines and pumps, also to any one who designs machinery involving radial faces to receive pressure, or to retain liquids or gases.

The following are the titles of the chapters which contain much useful information and many interesting suggestions: Machine Design; Rotary Bearings; Sliding Bearings; Power Transmission; Driving Belts; Rope Driving Gearing; Hydraulic Transmission; Steam Machinery; Connecting Rods; Cross-heads for Engines; Steam Boilers; Hydraulics; Water Power; Water-Raising Machinery; Centrifugal Pumps; Pipes and Fittings; Mechanical Drafting; Heat; Dynamics; Properties of Material; Tables and Memoranda.

The printing, paper and engravings of the book are admirable—as the work which issues from the Lippincott press always is—but the form of the book is not to be commended. Its size is 6¾ × 11¾ in., with limp covers, and it is bound and opens on the end. The lines run crosswise of the page, so that in reading it the book must be held with the long dimension of the pages in a vertical position. As the book is 22 in. long when open, it is extremely inconvenient to hold up, and it cannot be read with any comfort without a table or desk to lay it on.

It is also without an alphabetical index, for which omission there is no excuse for either Author or publisher.

A TREATISE ON MASONRY CONSTRUCTION: BY IRA O. BAKER, C.E., PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF ILLINOIS. New York; John Wiley & Son, 15 Astor Place (price, $5).

This book, to quote from the Author's preface, "is an outgrowth of the needs of the Author's own class-room."

Possibly the book was written simply for a text-book, but the result has been a book that will certainly prove of value to the practising engineer for a number of years to come.

There is one point that the examination of this book and some other of the recent engineering text-books brings forcibly before us, and that is the marked change that has taken place within comparatively few years in the subject-matter presented to students in the various schools of engineering. The amount of abstract theory given has been reduced and its quality greatly simplified. Much attention is now given to bringing before the student, in a most forcible manner, the intimate relation existing between correct theory and truly economical practice, and that no practice can be either physically or economically good that does not conform with correct theory; also to clearly setting before the student the *relative importance* of the various points developed in both theory and practice.

This becomes necessary in order to guard against an extreme refinement of practice on the one hand that costs more than it is worth, and an extravagant use of material on the other.

This use of "erring on the safe side," as it is called, results simply in a waste of material and money on light work with possibly some increased safety, but in heavy work, such as long-span bridges, becomes a source of positive danger. This book is a most excellent example of the manner in which a subject should be presented to students in our four years' course in civil engineering.

For convenience the subject is divided as follows:

Part I. Description and Characteristics of the Materials.

Part II. Methods of Preparing and Using the Materials.

Part III. Foundations.

Part IV. Masonry Structures.

Part I includes not only a description of the materials, stone, brick, lime, and cement, with their characteristics, but their requisites, methods of manufacturing brick, lime, and cement, together with some of the latest and most simple methods of testing their qualities.

Part II includes a description of the methods used in

the manufacture of mortar, concrete, and artificial stone, and the quarrying and dressing of stone for the construction of masonry.

Part III is on Foundations, including 1. The ordinary foundation, which subject is divided into three heads, viz.: (1) Soil; (2) Designing the Footings; (3) Preparing the Bed.

2. Pile Foundations: (1) Methods of Driving Piles; (2) Bearing Power of Piles; (3) Arrangement of the Foundation.

3. Foundations under Water: (1) Coffer Dam; (2) Crib and Open Caisson; (3) Dredging through Wells; (4) Pneumatic Process; (5) Freezing Process; (6) Comparison of Methods.

Part IV is on Masonry Structures: First, on Masonry Dams, including: (1) Stability of Dams; (2) Outlines of Design; (3) Rock-Fill Dams, including a comparison of Wood, Earth, Rock-Fill, and Masonry Dams. Second, on Retaining Walls, including: (1) Theoretical Formulas; (2) English and American Empirical Rules, with Details of Construction; (3) Bridge Abutments. Third, on Bridge Piers, including: (1) Theory of Stability; (2) Details of Construction. Fourth, on Culverts, including: (1) Water-Way Required; (2) Box and Pipe Culverts; (3) Arch Culverts. Fifth, on Masonry Arches, including: (1) Theory of the Masonry Arch; (2) Rules derived from Practice; (3) Arch Centers. There is also an Appendix giving Specifications for Masonry: (1) General Railroad Masonry; (2) Masonry Railroad Buildings; (3) Architectural Masonry; (4) Laying Masonry in Freezing Weather.

In the treatment of each of the above-mentioned subjects sufficient theory is given for the student or engineer to comprehend fully the general principles upon which sound practice must be based, and also full descriptions of numerous examples of actual work, together with a comparison of the results obtained by the use of the different methods and materials in practice.

The various portions of the book contain also the essential parts of the standard specifications of some of the best organized railroad companies in this country. There is one advantage Professor Baker has in placing this book before the engineering profession, and that is that it is the only book of its kind on the market, the only data upon the different points being scattered through proceedings of engineering societies and various engineering journals, and not available to the majority of students or engineers.

As a text-book it will well fill the purpose for which it was written, and it will also be a valuable addition to any engineer's library.

THE RAILWAY LIGHTING AND HEATING COMPANY'S FROST DRY CARBURETTER SYSTEM FOR LIGHTING PASSENGER AND OTHER RAILROAD CARS. Philadelphia.

This is a trade publication which describes the system of lighting cars mentioned in the title above. It forms a volume of 36 pages 9½ × 12 in., besides a number of folded lithographic plates. It begins with an advertisement of the system, which is succeeded by a comparison of the cost of service of five different systems of lighting cars. Instructions for "manipulating" the apparatus are succeeded by a general description of it and a list of parts necessary for the equipment of a car. The application of the system and its different organs are illustrated by excellent lithographic engravings, which are admirable examples of the draftsman's art, especially plates C and D. The printing and paper are both luxurious, but the "General Description" on pages 15–17 can hardly be regarded as a model of lucidity, although as trade catalogues go it is very good.

TEMPORARY CATALOGUE OF THE BOYDEN POWER BRAKE COMPANY. Baltimore.

In an introductory note or preface to this publication it is announced that it is a "temporary catalogue," issued to meet the immediate demands of the business of the Company, and that in the future a more complete descriptive catalogue will be issued. This statement to some extent disarms criticism, and perhaps all that need be said now is that the catalogue is a pamphlet of 26 large pages, and contains descriptions and engravings of the principal parts of the brake, which, in its general character, resembles the Westinghouse, although the mechanical appliances used differ considerably from what may be called the organs of its prototype. The engravings are good, and the mechanical work of the catalogue can also be commended, although the descriptions are, perhaps, not as full nor as clear as might be desired.

BOOKS RECEIVED.

TRADE AND TRANSPORTATION BETWEEN THE UNITED STATES AND SPANISH AMERICA: BY WILLIAM ELEROY CURTIS. Washington; Government Printing Office.

HIGH-PRESSURE STEAM AND STEAM-ENGINE EFFICIENCY: BY W. WORBY BEAUMONT. London, England; published for the Author. This is a paper read before the Society of Engineers by Mr. Beaumont.

REPORTS OF THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT: NOS. 107 & 107½, AUGUST, 1889. Washington; Government Printing Office.

THE RAILWAYS OF BRAZIL, A STATISTICAL ARTICLE REPRINTED FROM THE RAILWAY AGE, WITH NOTES AND ADDITIONS: BY JOHN C. BRANNER, PH.D. Chicago, Ill.; the *Railway Age* Publishing Company.

REGALE UNIVERSITA ROMANA, SCUOLA D'APPLICAZIONE PER GL' INGEGNERI: ANNUARIO PER L'ANNO SCOLASTICO, 1889–90. Rome, Italy; published by the University.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The papers included in this issue are Removal of Rock under Water without Explosives, by Frederick Lobnitz; the Steel Dock-gates of the Limerick Floating Dock, by William J. Hall; Foundations of Daly College, Indore, by David M. Litster; Movements of Sewer Air, by William S. Crimp; Perforated Cake-powder for Ordnance, by George Quick; West of India Portuguese Railway and Harbor Works, by Ernest E. Sawyer; Water-softening and Filtering Apparatus for Locomotive Purposes; Abstracts of Papers in Foreign Transactions and Periodicals.

ANALES DE LA SOCIEDAD CIENTIFICA ARGENTINA: ENTREGAS IV Y V, ABRIL Y MAYO, 1889. Buenos Ayres, Argentine Republic; issued by the Argentine Scientific Society.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE. BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, HORTICULTURAL DEPARTMENT: IX, SEPTEMBER, 1889. Ithaca, N. Y.; published by the University.

CENTRAL EXPERIMENTAL FARM, DEPARTMENT OF AGRICULTURE: BULLETIN NO. 5, AUGUST, 1889. Ottawa, Canada; issued by the Department of Agriculture.

ANNUAL REPORT OF THE PRESIDENT AND DIRECTORS OF THE OHIO & MISSISSIPPI RAILWAY COMPANY TO THE STOCKHOLDERS. Cincinnati, O.; issued by the Company.

PENCOYD IRON WORKS: STEEL CAR AXLES. Philadelphia; A. & P. Roberts & Company. The Pencoyd Iron Works have been engaged in the manufacture of iron car axles since 1852, and for several years past have made steel axles also, the plant consisting of one 20-ton and two 3-ton hammers, with the necessary furnaces, cranes, and other appliances. The present pamphlet contains in tabular form the results of a long series of tests of steel and iron axles made at these works.

THE MIDGLEY WIRE BELT COMPANY: CATALOGUE. Beaver Falls, Pa.; issued by the Company.

PENN IRON ROOFING & CORRUGATING COMPANY: CATALOGUE AND DESCRIPTION. Philadelphia; issued by the Company.

INJECTORS: CATALOGUE OF THE RUE MANUFACTURING COMPANY, 1889. Philadelphia; issued by the Company.

TRUE INWARDNESS: BY AN HONEST MAN. SECOND EDITION. Newton, Mass.; published by Sterling Elliott. This is a revised and enlarged edition of a catalogue which is unique and very attractive in its way.

BUCKEYE PORTLAND CEMENT: PROCESS OF MANUFACTURE, ETC. Bellefontaine, O.; issued by the Buckeye Portland Cement Company.

ABOUT BOOKS AND PERIODICALS.

THE last quarterly number of the PROCEEDINGS of the United States Naval Institute contains an interesting article on Electricity on Board War-ships, by S. Dana Greene, late Ensign, U. S. N.; a description of the Homestead Steel Works, by W. Richards and J. A. Potter; and an account of the Naval Ordnance Proving Grounds, by Lieutenant Albert Gleaves, U. S. N. Other articles are on Quick's Perforated Powder, by Fleet Engineer George Quick, R. N.; Shipbuilding on the Pacific Coast, by Lieutenant-Commander F. P. Gilmore, U. S. N., and a continuation of Professor Munroe's Notes on the Literature of Explosives. There is also the usual variety of notes on naval matters of interest.

The September number of the JOURNAL of the New England Water-Works Association contains the report of the annual convention, with the papers read at that meeting, including several of especial value to engineers engaged in this class of work. The report of the topical discussions also includes much that is of interest.

Mr. Kennan's description of the silver mines of Eastern Siberia in the October CENTURY—setting aside its special object, the description of the Russian convict system—will make a mining engineer grieve over the condition of a rich country with resources wasted by mismanagement. In its war papers the CENTURY has recently treated of telegraphy in war time; it might be suggested that something about railroad work in the same period would be of interest.

The POPULAR SCIENCE MONTHLY for November will contain several articles of interest to engineers. Indeed there are very few numbers of this magazine which do not present something of special value to this class of readers.

That very excellent paper the *Engineering and Building Record* has added to itself a bright red cover, increasing its size by the four pages which the cover makes. Very critical people may find fault with the shade adopted; but it has the merit of being distinctive and readily recognized, and is a gratifying evidence of well-deserved prosperity.

FIRE-BRICK FIRE-BOXES FOR LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

IN perusing your valuable JOURNAL of October, I became somewhat interested in the results obtained by Mr. Stefan Verderber upon Hungarian Railroads as well as those of Mr. Thomas Urquhart.

The more I studied the system, the more I feel in favor of the change that is requisite to be made in this variable climate of ours. I have had some experience, having had charge of locomotives and their construction in all climates, from the torrid climate of the Equator to the extreme cold of a Canadian winter, and in the more temperate zone of the Central States of America. It is a well-known fact, which is answered by the expense account of the American railroads in winter, that during summer very little trouble is experienced with bad flues, leaky fire-boxes, and cracked sheets. When December sets in, and winter, with its cold, chilling winds encounters the locomotive and commences to attack the vital part, which, like the human system, is the body or boiler, and lays its demand with unsparing hand not upon the cylinders, wheels, etc., at first, but on the vital parts, the fire-box, flues, and internal arrangements—the power-generating qualities, its very life—then immediately the trouble begins, and extraordinary exertions are made to generate the amount of steam required under the worst of conditions and climatic influences extant; causing extraordinary expansion from excessive heating of inside sheets, flues, etc., and fearful strains from outside influences of temperature, working in favor of contraction. This means an increase of repairs and expense account.

I am fully convinced that an immediate improvement can be made in the right direction, lessening not only the cost of production, but also the expense and repair account, by a proper change in construction.

I deem the method of lengthening the boiler or cylinder part and lengthening flues as part and portion of this improvement, and placing what was formerly the throat of the boiler inside of the furnace with a suitable crown sheet, the furnace being lined with fire-brick, which can never be suddenly affected by either the heat or cold; which sudden changes so often prove deterimental to the sheets, stay-bolts, etc., of the ordinary boiler as built. This method may involve the relaying of fire-brick in the furnace much oftener than repairing sheets, but will it not more than compensate by the gain in expense account, and by giving a safe, durable, and whole boiler for a greater period of time? I think so. I feel satisfied that these undue influences of heat and cold would have nothing to attack, either by cold draft outside or circulating drafts upward on the inside fire-sheets of a boiler of this description, as there would be none of those conditions to influence it before it could enter the flues to imperil their durability, while passing through the process of combustion, in reaching the sheets and flues of the cylinder boiler as proposed.

It is well known that some of the severest strains on a locomotive boiler result from the great expansion inside and the contraction outside—due to the action of cold on the side-sheets, etc., which it is impossible to cover properly. These strains tend to injure or break the stay-bolts, etc., which hold the inner and outer fire-box sheets together, but their effect is too often ignored.

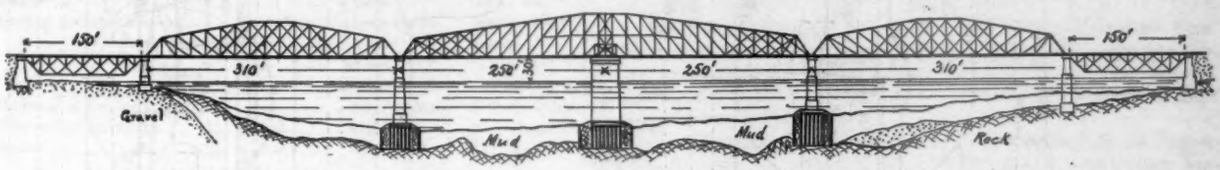
Not having tested the matter fully, I feel convinced that less than 33 per cent. of the steaming qualities are in and around the water-space of the ordinary fire-box. From my observations on the fires on different locomotives, I have known—among that number are many of the present American build, some French, and a great many of English manufacture, when engaged as locomotive engineer in Canada for several years where the Gunn, Good, Stephenson, Bristol, Fairbairn, Liverpool, and Birkenhead engines were in use—let me add that a boiler constructed on a good design, not remodeled from an old shell, but built from new material; one that would be designed for circulation of the water from the fire, toward the forward end, will be ultimately the locomotive boiler of the future. Such a design I should be in favor of applying and believe would be the most serviceable. WALTER S. PHELPS.

THE THAMES RIVER BRIDGE.

THE new bridge over the Thames River at New London, Conn., is now completed, and was opened for traffic on October 10. This bridge was built to complete the connection between the Shore Line Division of the New York, New Haven & Hartford Railroad and the New York, Providence & Boston Railroad, and to do away with the ferry heretofore in use across the river at New London. By its completion, the Shore Line between New York and Boston will have a continuous track and the delays incidental to the ferry transfer will be done away with.

The bridge (which was described in the JOURNAL for June, 1888, page 264) crosses the Thames River at Winthrop's Point, about half a mile above the present ferry crossing. This is the narrowest part of the river, but the nature of the bottom there required some difficult work on the piers; the place, however, was chosen chiefly for the reason that at that point the bridge would not interfere with the free access of shipping to the wharves at New London. Beginning on the western or New London side of the river, the bridge consists of one deck-span 150 ft. long; one through-span 310 ft. long; a draw-span 502 ft. long, having a clear opening of 225 ft. on each side of the center pier; one through-span 310 ft. long, and one deck-span 150 ft. long; the total length of the bridge is thus 1,422 ft. The bridge is entirely of steel, is built for a double track, and has a clear headway above the river of 30 ft. at high tide.

The western approach to the bridge is made by a line running from the present Union Station in New London northward until nearly opposite the bridge, where it turns eastward by a sharp curve, crossing the New London Northern track near the bridge. On the eastern side a new line has been built from the end of the bridge to Noank, which is somewhat shorter and very much straighter than the old road.



THE THAMES RIVER BRIDGE.

The surveys and plans for the bridge were made by Mr. Alfred P. Boller, of New York; the contractor for the foundations and masonry was Alexander McGaw, of Philadelphia; and for the superstructure, the Union Bridge Company, of New York.

An interesting feature in connection with the bridge is the machinery by which the draw is turned, and the ends of the draw-span dropped into place. This machinery is thus described: The engine for turning the draw is located beneath the middle of the roadway on top of the pivot pier, and, of course, turns with the structure as it revolves. It is a very compact steam plant, stowed away between the deep steel cross-girders, and the engine-room is to be housed in with double floor and hard pine finish, with iron stairways leading down to it. The engine is a double oscillating cylinder engine, with both cylinders 7 × 10 in., set at an angle of 120°, and both working upon one crank shaft. It is built by Joseph Edwards, of New York, and is especially designed for bridge turning. The power is transmitted by geared wheels proportioned 16 to 1, and is distributed to the turning pinions or to the rail-elevating and seating devices through the medium of two Frisbie clutches, which in turn are governed by levers bearing a toothed quadrant and operated simultaneously in opposite directions by a hand-wheel. The main gear-wheels are 36 in. in diameter, and are so combined with the clutch mechanism that as the power is taken off one set of gears it is applied to the other. The functions of this engine then are double. Extending under the floor of the draw-span for its entire length is a shaft carrying at its outer ends a worm which operates a series of cams upon a transverse shaft under the bridge floor. The end length of rail at each end of the draw-span projects 2½ ft. beyond the draw proper and this rail is fastened by a fish-plate only at its inner end. It lies in a trough made of angle-bars bolted to a base-plate, being free to move vertically for nearly its whole length. Its outer end is elevated by means of these cams, one of which is located under each rail at each end of the draw. These rails have planed ends so devised that a train running in either direction is running off the points, and on the thicker end of the other rail and in their normal position with the draw closed, they meet and exactly fit corresponding planed rails upon the fixed through spans, which lie in a shorter channel formed of angle-bars. This mechanism is somewhat similar to that employed at the Norwalk drawbridge. Something less than a complete revolution of these cams operates to elevate the ends of the rails at the draw-span above the rails of the fixed span, thus unlocking the track and allowing the draw to be turned. At the same moment, and by means of the longitudinal shaft through beveled gears and a lower transverse shaft, a vertical sleeve, cut with an interior female screw, is actuated, operating to raise a male threaded shaft carrying on the lower extremity a bearing-plate having a 6-in. downward projection which exactly matches a slot in the seat on the outer pier of the fixed through-span. The lifting of this seating device and the elevation of the rails is simultaneous, there being four of the seating screws to be freed from their complementary halves before the draw can be moved. This having been accomplished, the engineer throws over his hand from the shaft extending the length of the draw, and so throws into gear the shafts actuating the pinions which mesh into the circular rack around the top of the pivot pier. Two of these pinions are under the middle of the bridge on either side of the pivot pier, and when they begin walking about the rack the 1,200-ton mass of steel is sure to follow on its 58 steel wheels. Steam is generated by a very compact boiler also located beneath the bridge floor, and the stack will extend over 50 ft. in the air outside the bridge tower. Water will be taken at first from locomotive tanks, but a condenser is talked of. The engine-room will be furnished with an indicator showing the position of the bridge and with signals for necessary communication with the shore. The bridge will be locked open by the same mechanism which holds it closed, the bearing-plates resting then upon a foundation afforded by three heavy trestle bents erected upon the fender-pier.

The signaling mechanism for the bridge will be governed from a cabin erected in the bridge tower, and will be the interlocking system of the Union Switch & Signal Company, with electric safeguards which prevent the movement of the switches or signals after a train has entered the section protected. There will be nine working levers, with additional space for others as required, and they will control two signals in each direction, the derailing locks and switches and the rail-locks for the ends of the draw-span. The signals are of the ordinary semaphore form, swallow-tail blade for distant signal and the square-ended blade for the home signal. On the New London side the distant signal is located 1,740 ft. from the end of the draw. The home signal is 710 ft. from the end of the draw and the derailing switch 660 ft. from the end of the draw. This line is of an average grade of 38 ft. rise to the mile approaching the bridge. On the eastern approach the derailing switch is 760 ft. from the end of the draw, the home signal 50 ft. farther, and the distant signal 1,870 ft. from the end of the draw. These greater distances have been taken on account of the down grade of 42 ft. to the mile in approaching the bridge from the east.

The last movement of the signalmen before allowing the bridge to be opened will be to unlock the planed ended

rails already described, on the outer ends of the draw. This is accomplished by an additional safeguard designed especially for this structure and known as the detector and rail-lock. The ends of the rails to be elevated carry a downward projecting bolt, which can enter its hole only when the rails are down in their channels and the track is continuous. Then the movement of a lever will move a bar extending underneath both tracks, which carries four bolts, one for each rail. These are machine fitted and enter the holes in the lug, locking the rail down into position. If the signalman is unable to throw these bolts, he knows at once that the end rails are not in place.

It will be seen that the signal and other safety arrangements are exceedingly complete, and that every possible caution has been taken against accident.

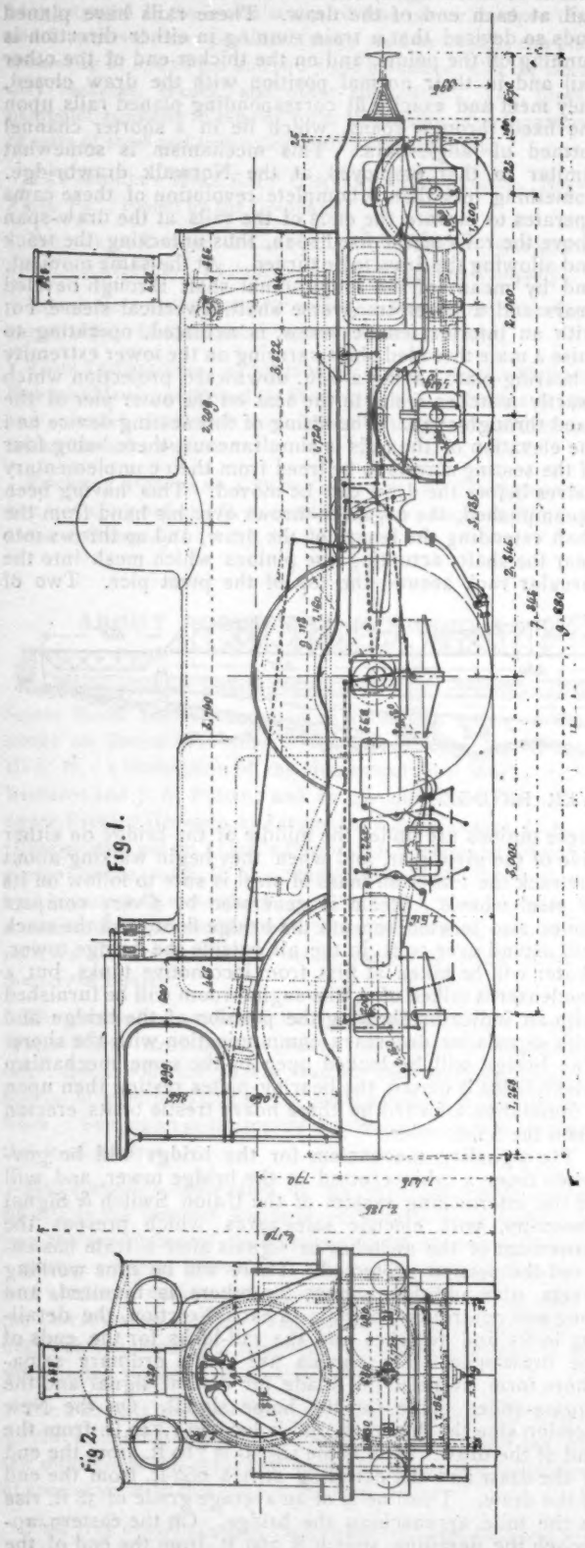


Fig. 1.

Fig. 2.

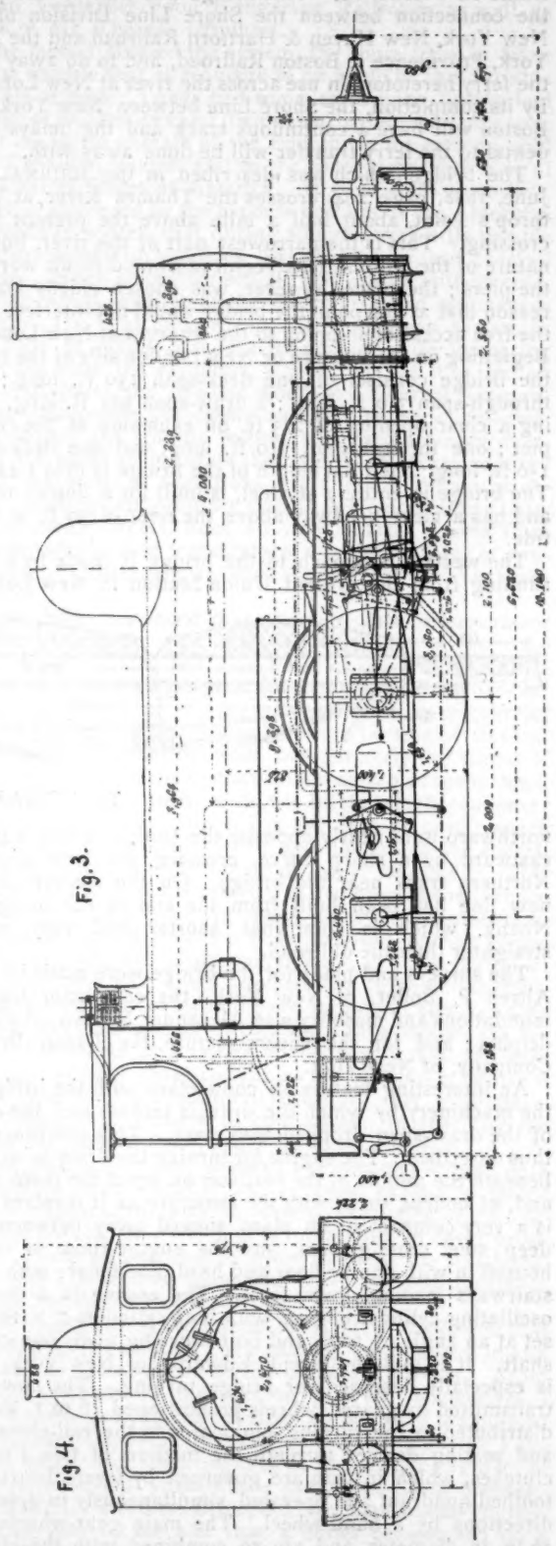


Fig. 3.

Fig. 4.

In this connection we have reproduced the cut which was published with the original description of the bridge, and which shows the position of the spans, the elevation of the piers, and the nature of the bottom upon which they were founded. The foundations required considerable work and really formed the most difficult part of the bridge,

FRENCH LOCOMOTIVES AT THE PARIS EXPOSITION.

THE Exhibit of the Northern Railroad Company of France, at Paris, includes two large locomotives, the first of which is an express passenger engine, having four coupled driving wheels and a four-wheel truck. This type of engine has been in use on the road for a number of years with very excellent results for passenger service, but the present engine differs slightly in details from those at first adopted. The differences are not important, however. This engine is shown in figs. 1 and 2.

While the general type is that of an American locomotive, it differs from the class common in this country in having the cylinders placed inside, and in the use of the crank axle. Other peculiarities which will be noted are the plate frame and the arrangement of the exhaust nozzle. The steam-chests are placed at the side of the cylinders instead of on the top, but are outside, thus reversing the common English practice, which is to place the steam-chests between the cylinders. They are very slightly inclined from the horizontal.

These engines are provided with a steam driver-brake. They are also provided with a vacuum-brake, which is the type in use on this road for passenger trains.

The general dimensions of this engine are as follows :

Diameter of boiler barrel	1.250 meters.	(4 ft. 1.21 in.)
Length of fire-box	2.020 "	(6 " 7 53 ")
Width " " "	1.012 "	(3 " 3.84 ")
Number of tubes	202	.....
Diameter " "	0.045 meters.	(1.77 in.)
Length " "	3.822 "	(12 ft. 6.47 ")
Heating surface, fire-box	11.000 sq. m.	(118.41 sq. ft.)
" " combustion chamber	2.800 " "	(30.14 " ")
" " tubes	97.000 " "	(1,044.14 " ")
" " total	110.800 " "	(1,192.09 " ")
Diameter of driving wheels	2.130 meters.	(6 ft. 11.86 in.)
Diameter of cylinders	0.480 "	(18.90 ")
Stroke	0.600 "	(23.62 ")

The total weight of this engine in service is 43.2 tons, of which 16.3 tons are carried on the truck, 14.6 tons on the main driving axle, and 12.3 tons on the rear or coupled axle.

The other engine exhibited by this Company is a compound locomotive, of what we should call in this country the mogul pattern, having three pairs of driving wheels coupled and a bearing axle forward. This engine is shown in figs. 3 and 4. The high-pressure cylinder is placed inside, in the smoke-box, with the steam-chest underneath, and is coupled to the main driving axle by a crank. There are two low-pressure cylinders, which are placed outside with the steam-chests on top, and which are also coupled to crank-pins on the main driving wheels. The high-pressure cylinder has a double valve, by which the admission of steam and its passage into the low-pressure cylinders is regulated. There is also a special valve provided, by which steam can be admitted directly from the boiler to all three of the cylinders, in case a special effort is desired in starting the engine on a heavy grade. The valve gear is of the Walschaert type.

The general dimensions of this engine are as follows :

Diameter of boiler barrel	1.346 meters.	(4 ft. 5.00 in.)
Length of fire-box	2.130 "	(6 " 11.86 ")
Width " " "	0.962 "	(2 " 1.88 ")
Number of tubes	208	.....
Diameter of tubes	0.045 meter.	(1.77 in.)
Grate area	2.091 sq. m.	(22.51 sq. ft.)
Heating surface, fire-box	9.300 " "	(193.11 " ")
" " tubes	104.500 " "	(1,124.87 " ")
" " total	113.800 " "	(1,317.98 " ")
Diameter of driving wheels	1.650 metres.	(5 ft. 4.96 in.)
" leading wheels	1.010 "	(3 " 3.76 ")
" high pressure cylinder	0.432 "	(17.01 ")
" low-pressure cylinders	0.500 "	(19.69 ")
Stroke of all cylinders	0.700 "	(27.56 ")
Total weight of engine in working order		52 tons.
Weight on leading axle		7½ "
" " forward driving axle		14½ "
" " main driving axle		15½ "
" " rear driving axle		14½ "

This engine has been in service about two years, and so far has given very excellent results. It is used for working mixed traffic on some of the lines of the Northern road, and has also been used for some time in running freight trains. In both classes of service a considerable economy in fuel is reported.

In the accompanying illustrations (taken from the *Revue Generale des Chemins de Fer*) fig. 1 is a longitudinal view and fig. 2 a front view of the passenger engine ; fig. 3 is a side or longitudinal view, and fig. 4 a front view of the compound engine.

SHIP-BUILDING ON THE PACIFIC COAST.

(Extract from article by Lieutenant-Commander F. P. Gilmore, in *Proceedings* of the U. S. Naval Institute.)

THE *Sitka*, a small paddle-wheel vessel, was the pioneer steamer in the waters of the Pacific Coast. She was built in the town of that name in Alaska, in 1847, was 37 ft. in length, with 9-ft. beam, and 3½ ft. depth of hold. She was brought to San Francisco on the deck of a sailing-vessel, made her trial trip on November 15, and, after short runs to Sonoma, Santa Clara, and Sacramento, she, after the discovery of gold, ran under the name of the *Rainbow* on the Sacramento River, and was finally lost in a gale while at anchor. The wreck of the *Beaver*, the first steamer that came into the Pacific from the south, now lies opposite Vancouver. She was also a paddle-wheel boat, and was for years in the service of the Hudson Bay Company in the Sound. She is not such a wreck but that she could be easily repaired.

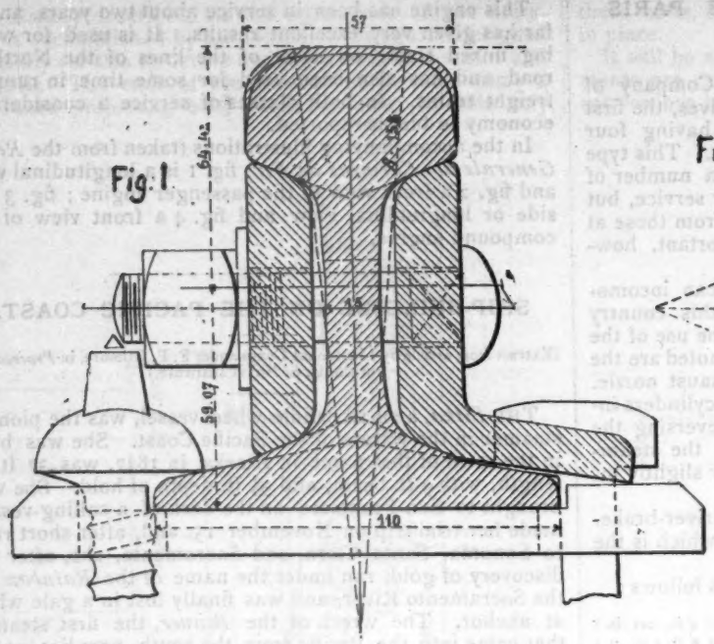
With the exception of the Union Iron Works of San Francisco, all the ship-building yards on the coast are for the construction of wooden vessels, the Union Iron Works having the only plant for building deep-sea vessels of any size of iron or steel.

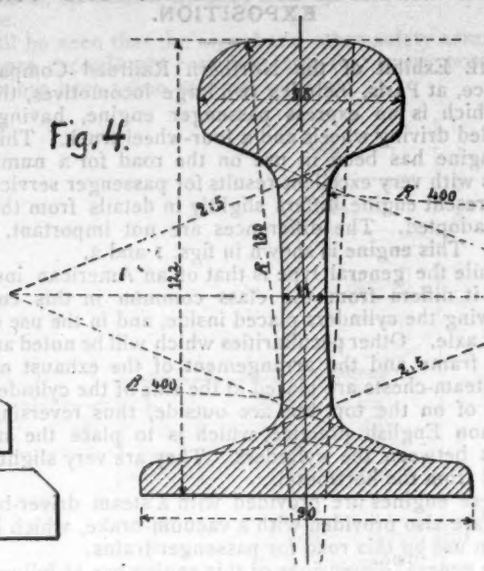
The abundance and accessibility of the timber on Puget Sound, with its tranquil waters, makes it a paradise for wooden ship-builders ; and with its coal and iron mines, it promises to be the same for the steel ship-builder. The durability of the Puget Sound timber was discovered during its extensive use for repairs. Its advantages are its great length, size, and lightness, and the tenacity with which it holds iron fastenings. Its cheapness was an offset against the high price of labor. There is now on the coast a large fleet of wooden vessels unrivalled for the lumber trade, and which challenge comparison with any other lumber fleet in the world.

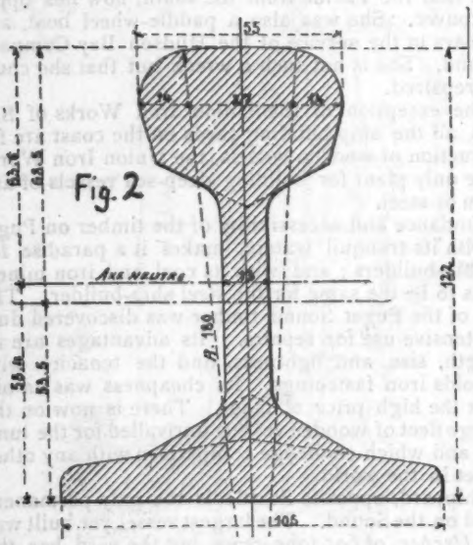
Hall's shipyard, opposite Seattle, is the only permanent one located on the Sound. The largest vessel yet built was the bark *Hesper*, of 695 tons gross, but the yard has the capacity for building any sized wooden ship. A steamer, intended for trade on the Sound, was lately launched at Tacoma. Small vessels are built at many places along the coast, principally on the Columbia and Willamette, and at Humboldt, Coos Bay, and Benicia.

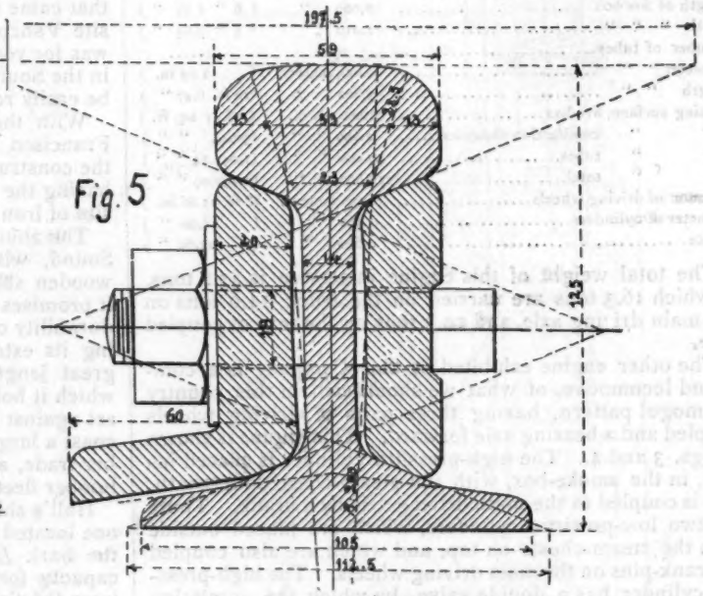
A large industry in San Francisco is the building of steam schooners for traffic along-shore. They are most of them engined, and many of them contracted for by the Fulton Iron Works. This firm has placed engines varying from 500 to 800 H.P. in about 80 of these vessels. The ferry-boat *Encinal* has engines of 1,200 H.P. Another great interest in San Francisco is the steam whaling fleet. Out of 47 vessels sailing from that port in 1888, 25 are owned there. In 1884 the catch of the six steamers built and equipped in San Francisco was greater than that of the entire Eastern fleet of 20 vessels sailing from the port, and including their two steamers. The whaling fleet gives employment to 1,800 men. What a nursery for a naval force !

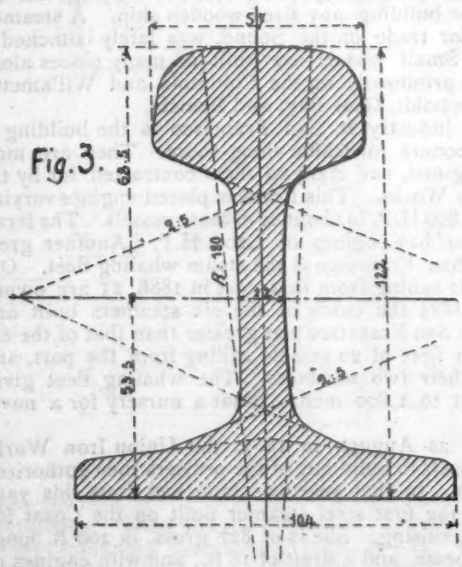
As early as August, in 1885, the Union Iron Works made proposals to build any of the cruisers then authorized by Congress. In that year was launched from this yard the *Arago*, the first steel steamer built on the Coast for deep-water cruising. She is of 827 gross, is 200 ft. long, with 30-ft. beam, and a draft of 16 ft., and with engines of 450 H.P. The Fulton Iron Works claim to have built at an earlier date a small iron steamer, the *Sucre*, of 50 H.P.

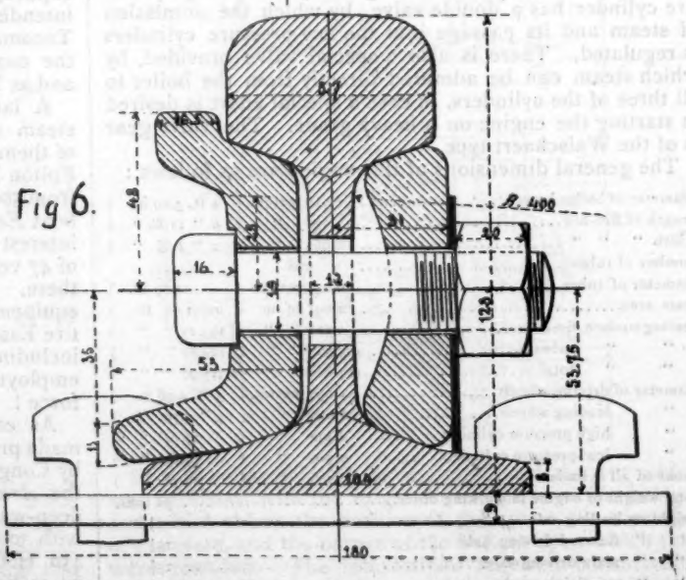












EUROPEAN RAIL SECTIONS.

Up to 1885 the vessels built on the Coast were of wood. Since that date the Union Iron Works have built and launched the *Charleston*, 3,200 tons; the *Pomona*, 1,246 tons; the *Premier*, 1,080 tons; and the tugs *Collis*, *McDowell*, and *Active*, all of steel. The *San Francisco*, of 4,000 tons, is on the blocks, and the contract awarded for the coast-defense vessel authorized by the last Congress. The engines of these vessels were manufactured at the machine shops of the works, the steel, castings, and heavy forgings being made at the Pacific Rolling Mills. The launching of the *Charleston* marked a new era on the Coast, the inauguration of a great ship-building trade. Encouraged by a well-considered policy on the part of the Government, the wooden fleet on the Coast, the vessels that are to carry our trade in the Pacific, and the cruisers and battle-ships of the Navy, can be built as expeditiously and as well as at any other yard in the country or world.

During the year 1888 there were built at and about San Francisco 59 sea-going vessels, mostly for the coasting trade. The climate is very favorable for the ship-builder. During the winter of 1887–88, but 10 days were lost on the *Charleston* because of the weather. Steel plates are never too cold to work or handle, nor in winter is half the time of a riveter lost while he blows his fingers. The summers are cool, with no rain.

The *Pomona* was contracted for with the Union Iron Works on September 14, 1887, and launched May 26, 1888. The *Corona* was contracted for with an Eastern firm, October 29, 1887, and was launched August 4, 1888. The former vessel cost $200,000, the *Corona* to cost $188,000, or $198,000 delivered in San Francisco. The *Pomona* is of 1,246 tons gross, 951 net, and the *Corona* is of 1,492 tons gross and 966 net. The *Pomona* has two boilers, and the *Corona* four, and both vessels have triple-expansion engines. The *Pomona* will carry as much cargo as the *Corona*, and runs on 20 per cent. less fuel, and she is the faster ship.

The company ordering these vessels had the use of the *Pomona* while the *Corona* was steaming around to the Pacific, and that trip is considered equal to a year's wear and tear in the regular work of the vessels. The above is cited only to show that the ship-builder on this coast can hold his own in material and workmanship.

Some interesting data was handed the writer lately of a steamer built when Thornycroft's reputation was young, and the fast torpedo-boat in its infancy. In 1876 the specifications for the iron steamer *Meteor*, to run on Lake Tahoe, called for a speed of 20 miles per hour. She was built at Marysville, Cal., and all material and machinery were teamed over the mountains. There was no previous record of a vessel's steaming 20 miles per hour. The *Meteor* is 64 ft. 6 in. long, with 10-ft. beam, and a draft of 5 ft. aft and 3 ft. 1 in. forward, and a depth of hold of 5 ft. She is of 19.5 tons displacement, with fuel and 12 passengers on board, and is divided into water-tight compartments. The boiler is of steel, locomotive type, and carries 150 pounds pressure. The engines are one pair inverted cylinders, 10 in. diameter and 12-in. stroke, and weigh 2,600 lbs. with all fittings. The propeller is of brass, three-bladed, and finished all over. The *Meteor* made 21 miles per hour repeatedly over a measured mile, and from Glenbrook to Tahoe City she made 12 miles in 38 minutes, or 18.9 miles per hour. The engines made between 270–280 revolutions, and were designed and built by W. R. Eckart. The largest torpedo-boat afloat, in 1881, was built by Thornycroft for the Danish Government. She was of 55 tons displacement, with a coal capacity of 10 tons. At full speed, as shown on trial as well as during a three hours' run on measured miles, she made 20 knots per hour.

What is most needed in San Francisco is an abundant and cheap supply of good coal. With this, even with the high price of labor, the shipyards here could compete with any in the world. Most of the coal comes from Australia and British Columbia. Mines are being discovered and opened at many places along the northern coast, and some reported very valuable are about being opened at Kenai in Alaska. The Kenai Company claims it can place coal in San Francisco at $3.50 a ton, with 10 per cent. profit. Of the 1,400,000 tons of coal received at San Francisco in 1888, nearly 700,000 tons were foreign and almost the whole of it transported by water. The importance of the absolute control of Puget Sound and the Columbia River, as well as the development of lines of supply between the two, needs no argument. At present, in case of war, San Francisco would be without coal at once, even if the whole coast were fortified. Efficient naval and merchant vessels are absolutely necessary.

The material for the steel vessels built on the coast is made and shaped at the Pacific Rolling Mills, and for quality is unexcelled. With its already extensive plant it would not be difficult for this firm to erect hydraulic forges that would turn out any shape for ship or gun. But it would have to be under a contract with the Government for a large enough order, running over some years, to remunerate the firm for its outlay. There are other firms in San Francisco ready to contract for building marine engines and boilers of any size. There is an abundant supply of good iron ore on Puget Sound. But in 1888 there were imported from Great Britain to San Francisco 18,393 tons of pig iron, against 2,037 tons from the Eastern States, and 1,940 tons from the Coast furnaces. The principal reason for this is that grain ships bring the iron for ballast. The Port Townsend ore is excellent, and there is also good Bessemer ore in California.

Besides the Government docks on the coast at Victoria and Mare Island, there is a large dry-dock at Hunter's Point in San Francisco, and the new hydraulic dock at the shipyard of the Union Iron Works.

THE WEAR OF STEEL RAILS.

[Condensed from a paper prepared by M. Louis de Busschere, Chief Engineer of the Belgian State Railroads, for the International Railroad Congress.]

ONE of the subjects for special consideration at the present meeting of the International Railroad Congress at Paris, was the Wear of Steel Rails, upon which a large number of reports have been submitted by the different railroads connected with the Congress. The present paper is intended to give a summary of the experiences represented in these reports and to cover the question as far as possible from the observations at hand. As will be seen, however, these observations have not been carried out on a sufficiently extensive scale, nor reported in a sufficiently systematic manner to enable the writer to reach any definite conclusions. A continuance of the observations on a larger scale, with reference to the subject and the next meeting of the Congress, is recommended.

In connection with this report, the *Bulletin* of the Commission of the Congress gives the standard rail sections in use on a number of important European lines, and it has been considered of interest to reproduce these sections in the accompanying plates. The table below shows the roads represented in the illustrations.

RAIL SECTIONS.

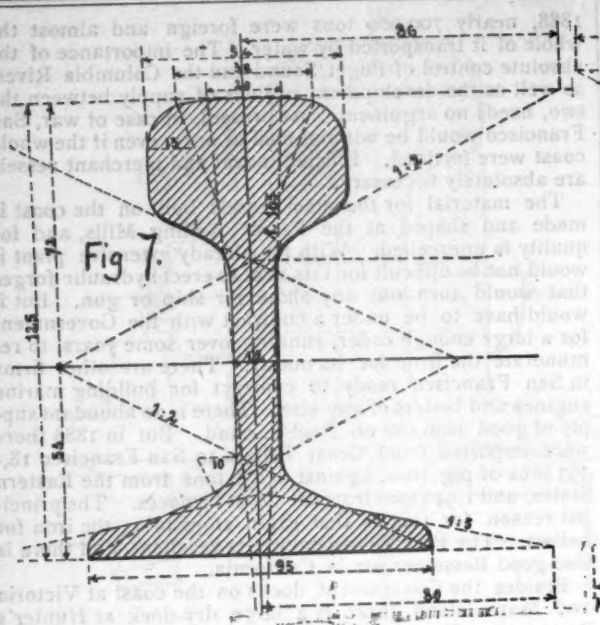
Fig. 1.	Kaiser Ferdinand Northern Railroad (Austria).
Fig. 2.	Austrian Northwestern Railroad, No. 1.
Fig. 3.	" " " No. 2.
Fig. 4.	" " " No. 3.
Fig. 5.	Austrian State Railroads.
Fig. 6.	Hungarian State Railroads.
Fig. 7.	Andalusian Railroad (Spain).
Fig. 8.	Belgian Grand Central Railroad.
Fig. 9.	Netherlands State Railroad.
Fig. 10.	Swiss Southwestern Railroad.
Fig. 11.	Netherlands-Rhenish Railroad.
Fig. 12.	Holland Railroad Company.
Fig. 13.	Riazan-Koslow Railroad (Russia).
Fig. 14.	Rostof-Woronege Railroad (Russia).
Fig. 15.	Belgian Northern Railroad.
Fig. 19.	French Government Railroads.
Fig. 20.	Midland Railroad (France).

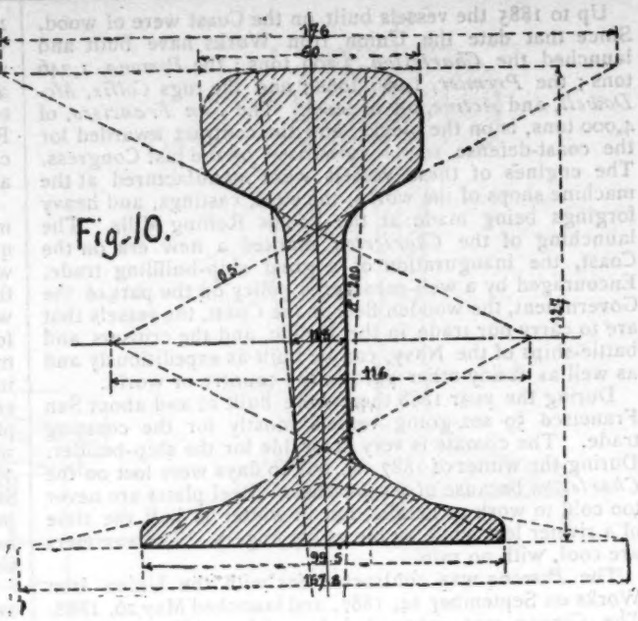
TIRE SECTIONS.

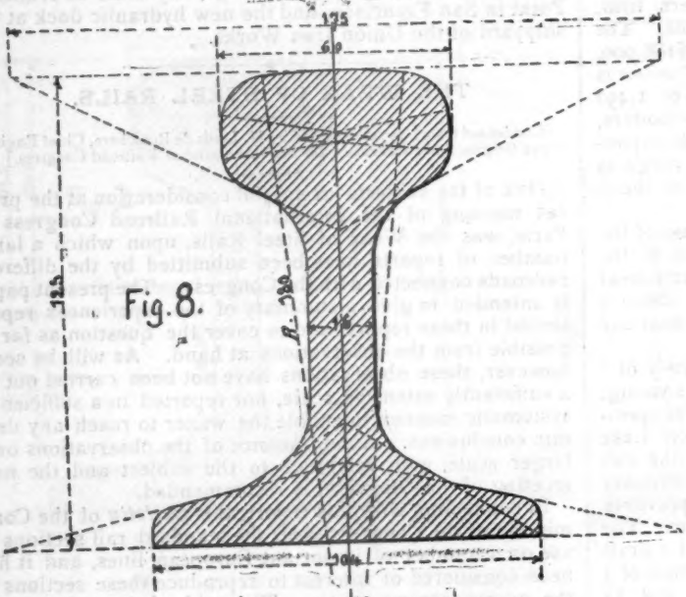
Fig. 16.	Kaiser Ferdinand Northern Railroad (Austria).
Fig. 17.	Austrian Northwestern Railroad.
Fig. 18.	Hungarian State Railroads.

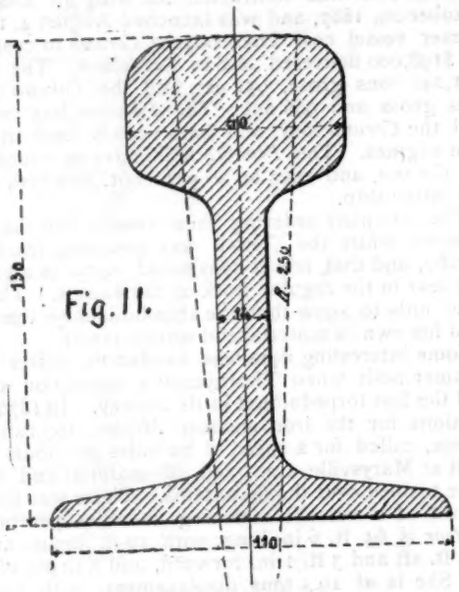
NOTE.—All measurements on the plates are in millimeters. The engravings are all made to the same scale—one-half full size.

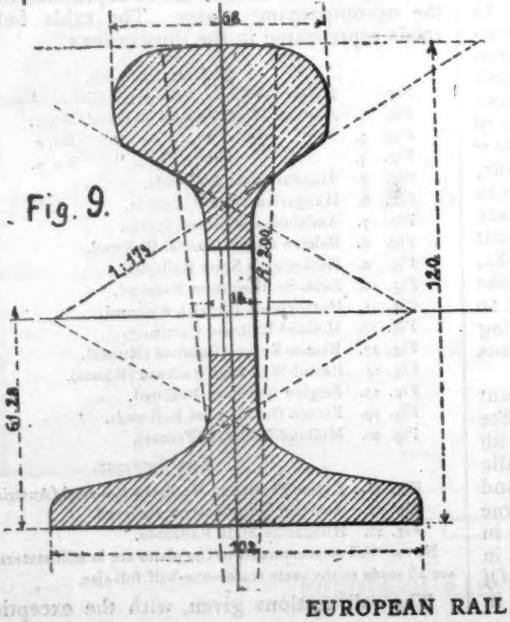
The rail sections given, with the exception of the two

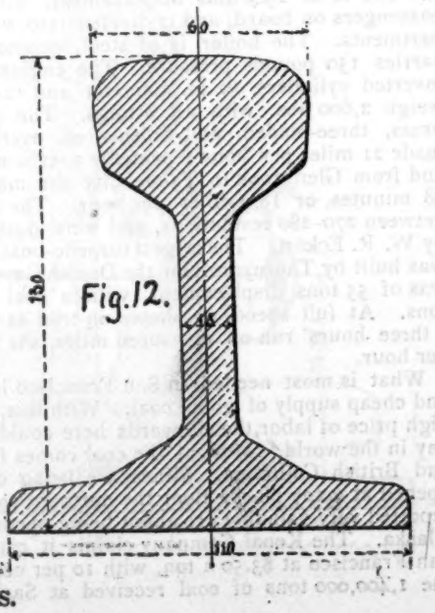












EUROPEAN RAIL SECTIONS.

shown in figs. 19 and 20, are all of the Vignoles type, which is commonly used in this country. The double-headed rail has a number of representatives, especially on the French and English lines, but most of these have been omitted as being of little interest here, the two given being selected for reproduction as types of the general form of that class of rail.

The comparison of the sections of rail in use on so many prominent railroads in Europe with those used in this country will be an interesting one, which there is not here space to give in any detail. One point which may be especially noted, however, is that the European railroads do not favor sharp corners, and that the radius of the curve joining the top surface of the head to the sides is in all cases large. Other points, both of resemblance and of difference, will also attract attention. It is to be regretted that sections of the joints used, do not in all cases accompany those of the rails, which would have afforded an opportunity for other interesting comparisons.

The greater part of the steel rails to which the report refers are Bessemer steel; for while rails of crucible steel and of puddled steel have been to some extent used in Europe, the Bessemer and allied processes of steel-making have met with most favor there as here.

The tables given by the different companies do not give, in general, data upon which can be based any general averages. As a specimen of careful observations, the following table of general results obtained on the Kaiser Ferdinand Northern Railroad may be of interest:

Conditions of Track.	No. of trains corresponding to a wear of		No. of tons corresponding to a wear of	
	1 mm. in height.	1 sq. mm. in surface.	1 mm. in height.	1 sq. mm. in surface.
Tangent, brakes not used.....	100,022	2,481	39,962,000	1,068,000
Tangent, brakes used.....	36,802	948	20,271,000	522,000
Curves, brakes not used.....	81,052	2,126	34,529,000	895,000
Curves, brakes used.....	31,784	767	17,931,000	430,000
Average for sections on tangents.	77,252	2,097	35,038,000	.....
Average for sections on curves..	62,897	....	28,430,000	.....
General average, all sections.....	69,460	....	31,451,000	.....

The wear given is the average of the two rails in the track, and the sections on which the observations were taken are all double track.

The following table shows the result of some interesting observations made on the Austrian Northwestern Railroad with relation to the effect of different kinds of supports on the wear of the head of the rail. In this case several sections were included in the observations, and the conditions on each are given:

Kind of Support.	No. of trains corresponding to a wear of		No. of tons corresponding to a wear of	
	1 mm. in height.	1 sq. mm. in surface.	1 mm. in height.	1 sq. mm. in surface.
Longitudinal sleepers:				
1. Tangent and level.....	44,500	1,068	13,510,000	324,000
2. Level, curve 1,000 m. radius	43,750	925	13,160,000	283,000
3. Grade of 0.2 per cent., part tangent, part curve.....	41,300	948	12,350,000	290,000
Iron cross-ties:				
Level, curve of 400 m. radius..	40,000	1,009	12,050,000	306,000
Wooden cross-ties:				
1. Curve of 380 m. radius, grade 0.75 per cent.....	42,417	1,193	11,760,000	283,000
2. Tangent, grade 1 per cent..	37,289	923	10,310,000	256,000

From this it appears that the wear of rails carried on wooden ties is somewhat less than on metal ties. These single observations, however, can hardly be considered as settling this point.

The observations made on the reports submitted by the different railroad managements, while many of them are of interest, are too long to be fully given here. The general summary and the conclusions based on these reports are, however, given below very nearly in full as written by M. de Busschere.

To sum up and review all the reports which have thus been submitted to the Congress and to arrange them in a systematic order to permit of their proper discussion is no easy task. The circumstances under which the observations were taken differ very much, and unfortunately the local conditions are not completely given in many cases where there has been unusual wear. These cases of abnormal wear are often to be attributed to complex causes, the action of which it is difficult to measure.

We will therefore limit ourselves to speaking of those general causes the influence of which seems to be established by the greatest amount of evidence.

An important question presents itself at the outset. Is it best in the observations to consider the wear in height or the wear in surface?

This point settled, is the wear to be determined by the number of trains or by the number of tons passing over the rails?

In this it must be understood that account is to be taken alone of the wear of the rail due to use and not of that resulting from rusting, oxidation, or other chemical action. This question decided we may proceed to examine the different points affecting the life of the rail.

1. *Chemical Composition.*—The French companies use a hard steel, according to the tables which have been presented. The wear of the rails on the Paris, Lyons & Mediterranean Railroad on a tangent and a level may be averaged at 1 mm. for 110,000 trains, or 30,000,000 tons; on the Eastern Railroad—where the rails weigh only 30 kgs. per meter—the wear is 1 mm. for 100,000 trains and 20,000,000 tons; on the Orleans Railroad the wear seems to be 1 mm. for 93,000 trains. With relation to the last-named road, however, it may be remarked that we cannot apply to so extended a system the results of observations made on a single system. Bearing this in mind it may be said that these figures do not differ greatly as to the number of trains.

On the Austrian Northwestern Railroad the steel also has a high proportion of carbon, but there is a smaller quantity of manganese; on this road the wear on a tangent and a level is 1 mm. for 44,500 trains.

On the Netherlands State Railroad the rails which have given the best results contain 0.366 of carbon and 0.637 of manganese, and the average wear reported is 1 mm. for 32,400 trains.

The Austrian railroads, outside of the Northwestern, use a mild steel. On the Kaiser Ferdinand Northern Railroad the wear on a level track, especially on single-track lines, is much greater, whether we take the number of trains or the tonnage. The resistance to wear on the Hungarian State Railroads is considerable, but here again it is impossible to make a general average from a single observation taken on so extensive a system.

On the Netherlands-Rhenish Railroad the steel contains little carbon but a high proportion of manganese. The resistance to wear here, taking the tonnage as a basis, is 1 mm. for 26,000,000 tons.

Manganese is one of the hardest metals and will even cut glass. Iron comes only fifth among the metals in point of hardness. Manganese, then, should have the effect of making the iron harder. On the other hand, it oxidizes rapidly when exposed to moisture and decomposes water with a rapidity which increases with the temperature. It must, therefore, be considered that in Holland, where the climate is very damp, a high proportion of manganese will exercise a considerable influence upon the wear of the rail. These observations coincide with the experiments made and the theories formed by M. Couard and M. Grüner.

2. *Methods of Manufacture.*—In France the rails used are nearly all of Bessemer steel, and it is generally considered that these are superior to the Martin steel. In Austria the steel-works generally use the Thomas process, by which manganese, phosphorus, and other foreign elements are taken out. These observations, however, are not sufficient to show all the elements which may cause the

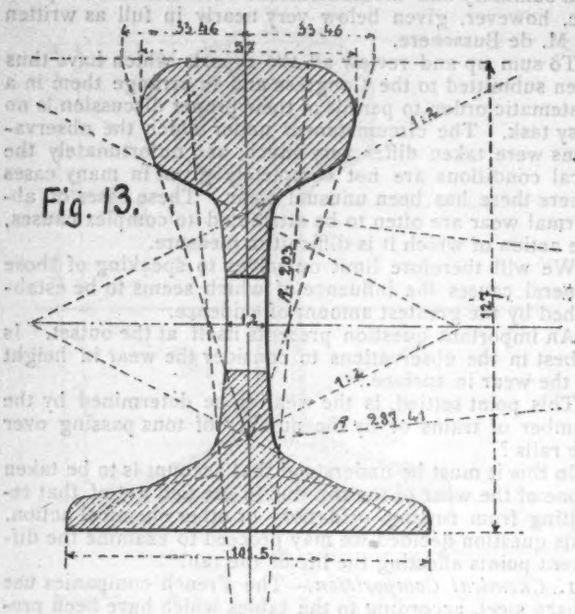


Fig. 13.

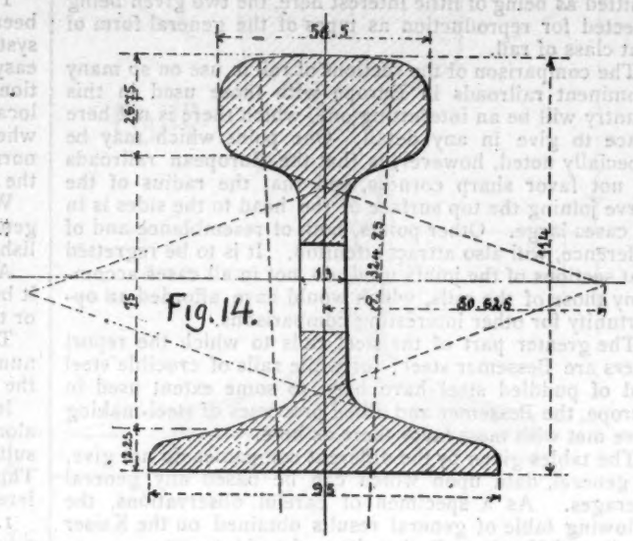


Fig. 14.

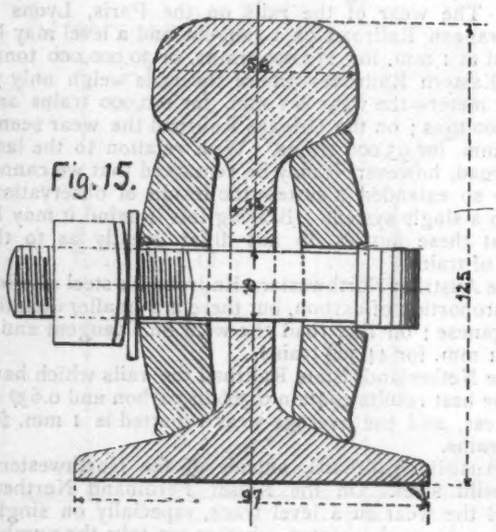


Fig. 15.

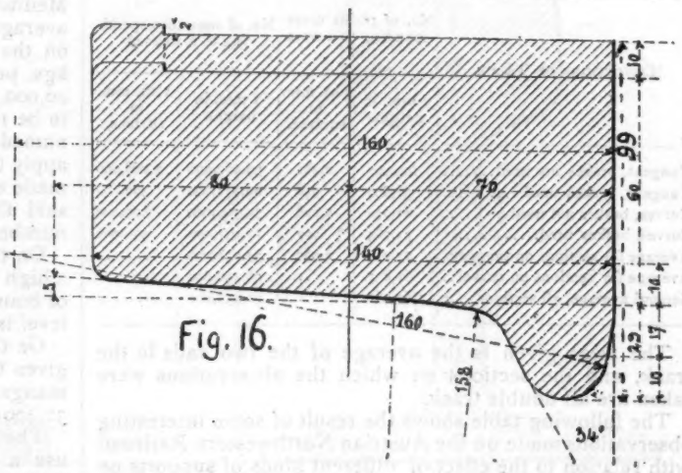


Fig. 16.

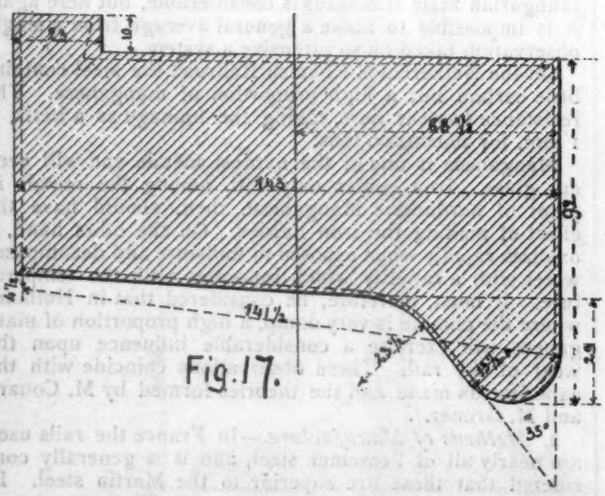


Fig. 17.

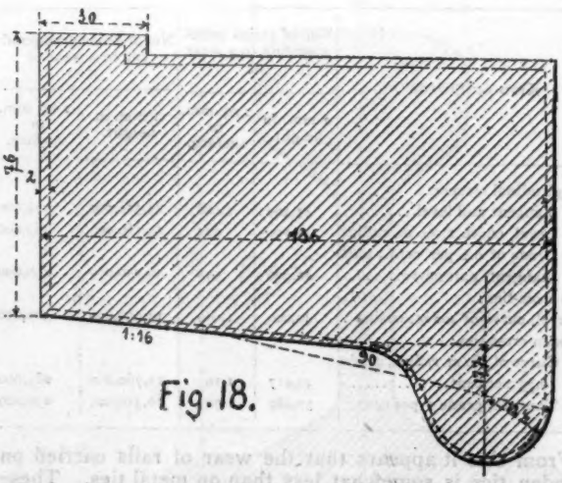


Fig. 18.

EUROPEAN RAIL AND TIRE SECTIONS.

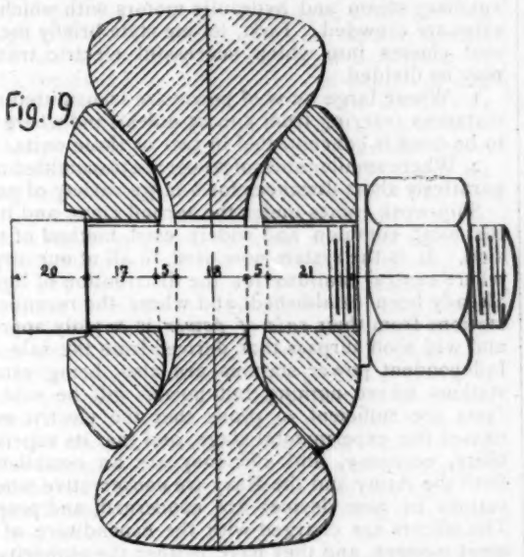
quality of the rails to vary. For this purpose very careful observation is necessary. It is well known that rail steel may differ slightly in quality in two successive heats, and that sometimes even the metal in the same rail is not homogeneous. This has often been indicated by experiments made on test-pieces cut from rails of different manufacture.

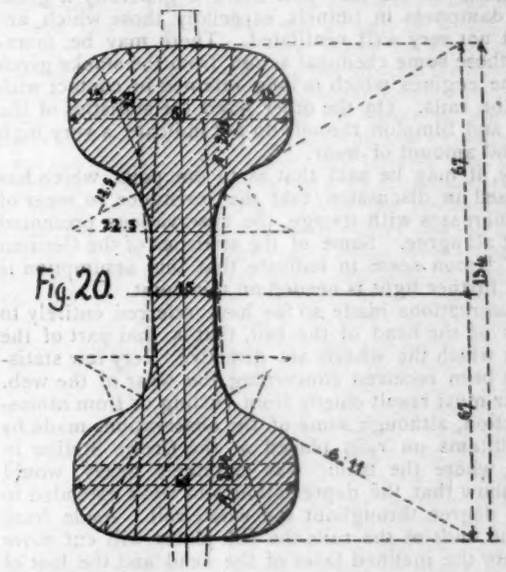
3. *Size of Rails.*—The reports received have been too indefinite on many points and too few in number to permit us to indicate exactly the influence on a rail of the following points:

1. The weight of the rail.
2. Its modulus of flexion.
3. Its length and the number of supports.
4. The section of the head.
5. The proportion of the three parts—head, web, and foot.
6. The nature of the supports.
7. The system of joints, supported or suspended.

We may nevertheless, from the statistics at hand, reach certain conclusions:

1. Other conditions being equal, the resistance of the rail to wear increases with the resistance to vertical strains.





EUROPEAN RAIL SECTIONS.

2. That wooden ties seem better as far as the wear of the rail is concerned.

3. It is probable that the section or form of the head has a considerable effect on the surface wear; but in order to reach a proper decision on this point, a great number of comparative tests must be made and the sections of a large number of rails must be taken.

In the figures given in the report of the German Railroad Union for 1879–84, diagrams of 140 different rail sections are given, and of these several show considerable side-wear, as shown in the following table:

Form of head.	Total number.	Showing much lateral wear.
Rectangular.....	68	13
Narrower at top..... ...	60	13
Narrower at base.....	12	4

From this it appears that the third form, that is the head narrower at the base, presents the least advantages. The influence of the inclination oft he rails, of the coning of the tires, and of the greater or less differences in hardness of the steel used for the tires and for the rails, can hardly be drawn from the observations of which we have the results.

4. *Influence of Grades.*—The influence of rising grades on a double-track line seems to be very slight, except in those cases where the grades become very heavy and require the use of very powerful locomotives to draw the trains.

On the other hand, the influence of falling grades is very marked, especially where it passes a certain limit so that the brakes must be used to regulate the speed of the trains.

When on a double track a rising grade succeeds to a falling one, we find almost always greater wear at the bottom of the falling grade and at the foot of the rising than on the level track which separates them. This increase of wear would very naturally result from the fact that the engineer would increase at such a point the speed of his train in order to attack the rising grade to the best advantage. This conclusion is supported by the observations made by the German Railroad Union and on the Hungarian State Railroads. The wear of the rail on the single-track lines appears to be influenced very much more by the grade than on a double-track line.

5. *Influence of Curves.*—The influence of curves on wear is shown by the observations made on the Austrian Railroads with considerable care. It increases as the radius of curve decreases. Nevertheless, its absolute value is not great when we consider the wear in height only without taking account of the lateral wear. The wear in height on the inner rail is always very much greater than on the outer rail, which is usually elevated. It would have been very interesting to secure exact statements of this difference in the wear, so that we could ascertain to what degree it varies with the super-elevation of the outer rail; but the observations are not sufficiently numerous for that purpose and more careful experiments must be waited for.

6. *Wear in Stations and Yards.*—This, as might be expected, is usually very much greater than on the open road. This proceeds not only from the greater number of passages over the rail, but from the constant use of brakes, and the question in many respects is similar to that of the wear on heavy grades where brakes are frequently used. It may be assumed safely from the evidence which we have that the wear varies with the frequency of the action of the brakes. It is to be noted that it is greater where continuous brakes are used than where the old hand-brakes are still employed. This result is a natural one, since when the brakes can be easily applied and at the will of the engineer, they will be much more frequently used.

7. *The Influence of Climate and Atmospheric Conditions.*—On this point again it may be said that observations are not yet numerous. It also appears that in Holland the wear is more rapid than anywhere else, and this seems to be due in part to the great dampness of the atmosphere of that country.

It may also be said that the purity of the air has considerable influence upon the wear of steel rails. If, for instance, we take three different sections of the Belgian State Railroads where careful observations were made, we find that on one section there has been a wear much

more rapid than on others of nearly equal traffic. Now this section passes through a country in which there are numerous iron furnaces, steel works, coke-ovens, and other factories, from which great quantities of smoke and gaseous matters are constantly given out, and there can be no doubt that this exercises a certain rusting or oxidizing action upon the rails.

8. *Ballasts.*—The influence of the ballast on the wear of the rails, while not yet exactly determined, appears to be very considerable from such reports as have been received relating to this point. It seems that with sand-ballast the wear is much greater than with stone or gravel. The probability is, that with sand-ballast very much the same action takes place as where sand is used to prevent the wheels of the locomotive from slipping—that is, little particles of sand are blown upon the rail and a greater degree of friction results by which the rail is worn or cut away. Some remarkable figures have also been presented showing that the wear is very much greater where cinders or broken slag are used for ballast; but further observations are needed on this point.

9. *The Influence of Tunnels.*—Such figures as have been presented, showing the increase of wear in tunnels, may be explained by the fact that there is generally a great deal of dampness in tunnels, especially those which are long and not very well ventilated. There may be, moreover, in these some chemical action from the smoke given out by the engines which is long retained in contact with or near the rails. On the other hand the statistics of the Gothard and Simplon tunnels do not indicate a very high or unusual amount of wear.

Finally, it may be said that as to one point which has been raised in discussion, that the resistance to wear of the rail increases with its age, the observations presented do not at all agree. Some of the statistics of the German Railroad Union seem to indicate that this assumption is true, but further light is needed on this point.

The observations made so far have referred entirely to the wear of the head of the rail, that is, that part of the rail upon which the wheels act directly. Very few statistics have been received concerning the wear of the web. This wear must result chiefly from rusting or from atmospheric action, although some of the observations made by Price Williams on rails placed at the Crewe Station in England, where the traffic was extremely heavy, would seem to show that the depreciation and wear extended to a certain degree throughout the whole rail. Aside from this, at the ends of the rails the fish-plates will cut more or less into the inclined faces of the head and the foot of the rail against which they bear. The hammering or abrupt action produced by the passage of the wheel over the joint will necessarily produce a succession of slight shocks or frictions. These will increase in effect as the speed of the train and the load carried by the wheels increase. Whether there is any influence exercised on this wear by the use of a greater or less fishing-angle, is not at present apparent.

As to the wear of the foot or base of the rail, very few observations have been presented, as most companies do not seem to have considered it of much importance to make careful observations on this point. It may be said that the foot of the rail is very often covered with ballast, so that consequently its wear does not appear at all times, and is seen only when the track is reballasted or the rail removed. Moreover, to ascertain whether there has been any wear of the foot will generally require very careful observations.

On the Belgian State Railroads it is reported that on the lines of heavy traffic the base of the rail wears at the points of support at the rate of about 1 mm. per year. When there are chairs or plates between the rail and tie, the wear is more rapid, but the report does not show what the exact effect is. It is also stated that certain kinds of ballast corrode the base of the rail and cause a considerable wear.

It would appear from the observations made above that thus far we can only establish a few general laws. Very much better results will be obtained if the railroads connected with the Congress will establish numerous points for observation of the influence which different local circumstances and the different conditions of grade, curves, etc., etc., may have upon rails of the same form, weight, and conditions of manufacture. There should be also a general form agreed upon on which reports on the wear of rails should be made to the Congress, and this report should cover all the points which have been indicated, giving information which could be carefully analyzed, and will enable us after some years to determine finally the laws covering the wear of rails.

THE USES OF ELECTRICITY ON SHIPBOARD.

THE following extracts are from a very interesting paper by Mr. S. Dana Greene (late Ensign, U. S. N.), published in the latest number of the *Proceedings* of the United States Naval Institute. It will be seen that many of his remarks will apply to steamships for commercial purposes as well as to war-ships. After some general statements as to electric motors, the paper proceeds as follows:

I do not intend to go into the theory of the subject, but rather to try and show how and why electric motors can be advantageously substituted aboard-ship for many of the auxiliary steam and hydraulic motors with which our new ships are crowded. First, let me state briefly the two general classes into which successful electric transmission may be divided.

1. Where large units of power are transmitted over long distances (varying from 5 to 25 miles), and where the work to be done is concentrated in two or three units.

2. Where smaller units of power are transmitted over comparatively short distances for a large variety of purposes.

Ship-work comes under the second class, and it is by far the most common and widely used method of transmission. It is the system now used in all of our large cities, where central stations for the distribution of lights have already been established, and where the revenue to these stations from their *sale of power* is rapidly approaching, and will soon surpass that derived from the sale of *light*. Independent power stations are also being established, stations where nothing but power will be sold. These facts are sufficient to prove that the electric motor has passed the experimental stage, and that its superior reliability, economy, and efficiency are an established fact. Both the Army and the Navy are conservative where innovations or new devices are concerned, and properly so. The officers are charged with the expenditure of government moneys, and they have neither the authority nor desire to develop new commercial enterprises. It is their duty to take advantage of these new enterprises when they have proven themselves successful, and when they can be applied with advantage to either service. A bill was before Congress at its last session to appropriate a generous sum of money for the development of the electric motor for naval uses, and it is to be hoped that this action of Congress will receive the cordial approval and support of all naval officers.

The work required of the auxiliary engines of one of our latest type of vessels may now be divided as follows:

1. Steam, air and condenser pumps located in engine-room, both for main and auxiliary condensers.
2. Steam pumps for fire purposes, for pumping out the ship, washing decks, etc.
3. Steam reversing engines for each engine.
4. Steam-engine for jacking the engines.
5. Steam steering engine.
6. Steam capstan engines.
7. Blower engines for producing forced draught in the fire-room.
8. Ventilating engines for ventilating the living spaces below.
9. Hoisting engines. Under this head are included steam ash-hoists and hydraulic ammunition-hoists.
10. Steam winches about the decks for lifting heavy weights, swinging out boats, etc.
11. Steam or hydraulic training engines for large guns.
12. Steam-engines for driving the dynamos.
13. Steam-engines for working lathes, drills, etc., in workshops.

Taken together, these auxiliaries will aggregate 40 or 50 engines on a large ship, representing perhaps 200 H.P. The engines, however, are never exerting their maximum power at the same time; hence if the work were done by motors, not over 60 to 70 per cent. of this 200 H.P. (allowing liberally) would have to be provided for in the dynamo room.

Now I hold that the electric motor can replace every one of these auxiliary engines, and do so with a great saving in first cost and space occupied, and make the whole system of supplying auxiliary power cheaper, more efficient, simpler, and generally more satisfactory to every one.

It will be seen at a glance that it is necessary to distribute steam to every one of these auxiliary engines. Even the hydraulic machinery, very complex in itself, must have a steam-engine to operate the compressing pumps. The engines are scattered all over the ship, from the capstan engine in the forward compartment to the steam steerer in the after compartment. To each engine it is necessary to run a separate steam and exhaust-pipe. These pipes, varying from 3 in. to 5 in. in diameter, must pass through water-tight bulkheads, at each one of which a water-tight packing joint must be made; they must bend and twist and turn so as to take up as little room as possible, out of harm's way; they must be heavily lagged wherever they pass through officers' or men's quarters; finally, expansion joints must be provided between rigid bulkheads, or there will be constant leaks at all joints and flanges or else buckling of the pipes. On board the *Atlanta*, for the first year after the ship went into commission, a gang of men were kept busy repairing leaks and breaks in the steam piping. On a ship like the *Maine* or *Texas*, the piping for the auxiliary engines will run up into the *miles*. The first cost of laying the pipe is enormous; it requires constant attention to keep it in good condition, and even when in good condition, the pipes are hot and cumbersome and the engine dirty and noisy. If repairs are to be made to engines, they must be made by a machinist; a machinist is necessary to operate the engines. If a steam-pipe should be struck by a shot in action (and it would be a hard matter *not* to strike one), there would be a rush of steam at 80 or 90 lbs. pressure within the compartment where the shot entered, which would probably seriously injure or demoralize the men in that neighborhood. The engine connected to that pipe (and it might be the steam steerer) would probably be useless during the rest of the fight.

As to the efficiency of these auxiliary engines, it is probably very low, taking into consideration the fact that there is necessarily much loss in the pipes from radiation, condensation, and back pressure, and that small, simple engines of the type necessarily used are notoriously wasteful of steam and uneconomical in operation.

The mechanical applications made necessary by the use of auxiliary steam-engines deserve notice. The steering engine is located at the stern of the ship, where it can operate directly on the tiller. The steering of the ship must, for obvious reasons, be done from forward. The usual method of operating the valve of the steam steerer from the pilot-house is to run a line of shafting from one point to the other, the shafting being operated either by hand or by another engine in or under the pilot-house. On board the *Atlanta* this shafting passed along overhead on the gun-deck, thence down to the berth-deck, and through the ward-room, until it finally reached the steering engine. In this distance it made no less than *eight* changes of direction, necessitating 16 bevel gears beside clutch couplings for each of the three wheels. A 1-lb. Hotchkiss shot coming in on the gun-deck would knock the shafting out of line in a second, and the ship would then have to be steered by word of command along from the conning tower to the steering compartment. Another example of the cumbersome mechanical devices made necessary by the use of steam is the gun-training engine for the 8-in. B. L. R. The engine for it took up so much room that it could not be put on the gun-carriage. It was, therefore, put in a room by itself on the orlop-deck, and connection was made to the carriage by a vertical shaft running up through two decks. The amount of power lost in friction and change of direction is great, and the executive officer's room was spoiled by having an ugly shaft running down through it. I mention these particular cases not to criticise the devices in themselves, but to show the non-adaptability of any system for ship use which makes such devices necessary.

Now, in what respects will the application of electricity be an improvement over the present system? Instead of the steam and exhaust pipes, 4 in. or 5 in. in diameter, being run all over the ship, we have in the first place our main conductors, running fore and aft, and secure below the water-line from shot and shell. The mains are perhaps ½ in. in diameter instead of 4 in. In each compartment where a motor is located, vertical branch lines are run to the motors and lights. These wires can be bent around corners or taken over or around obstructions at will. They require no elaborate water-tight slip joints at bulkheads; a half-inch hole with a small stuffing gland inserted is all that is needed. They require no lagging to make living quarters inhabitable; no expansion joints to prevent buckling of the bulkheads or leaks in the wires. The branch lines being run vertically, to a certain extent at least, present a minimum target to an enemy's shot. If a wire is shot in two, there is nothing to damage the man or create a panic among them; the most ignorant man aboard-ship by a single twist can splice the break in a few seconds, and the motor will run as well as it did before. In fact, nearly every objection raised to steam-pipes is eliminated. When we come to the motors, the advantages are equally marked. For equal horse-powers the electric motor occupies less than half the space of the steam-engine and weighs less. There is no heat or escaping steam about the motor. Any "idler" can operate it by opening or closing a switch; and beyond an occasional filling of self-oiling bearings and cleaning of the commutator, the motor runs itself. The motion is *rotary* instead of reciprocating, which means invariably much more quiet operation, less wear and tear of parts, and simpler mechanical applications. These are the advantages possessed by the electric motor that have led to its extended application on shore in place of steam. They are the same advantages which will be obtained by its use on board-ship. Two questions which are commonly raised about motors on shore by persons unacquainted with them will doubtless be raised by some officers in the service. They are, first: Can motors be made of sufficient size to do the work required of them? and second, Can they be relied upon to do the work as well and with as few break-downs as the steam-engine? The first question can readily be answered by simply stating that the regular *standard sizes* of the motors made by the Sprague Company range from one-sixteenth of 1 H.P. to 80 H.P., the list comprising forty or fifty types of machinery. In every case the rated H.P. is that *delivered from the pulley* of the motor. On all motors above 5 H.P. in size, the commercial efficiency (that is, the ratio $\frac{\text{H.P. given out by motor}}{\text{H.P. absorbed by motor}}$) ranges from 80 to 90 per cent.

The second question is best answered by a reference to the commercial world, where hundreds of these motors, of all sizes and types, are running 8, 10, and 12 hours a day, every day in the year, and on which the repair account in many instances does not amount to $10 for the year. It is in this direction that the greatest advance has been made in motors during the past three or four years. When they were first introduced, troubles with the field coils, "crossed" or "burned out" armatures, and commutators all cut to pieces by sparking and improper construction, were not of unfrequent occurrence. To-day such a mishap is extremely rare. Formerly, a motor was generally considered as a delicate piece of mechanism which must be kept under a glass case and labeled "handle with care." To-day we put a pair of motors under a street car, and run the car through snow, slush, mud, or rain, the car doing continuous duty for 16 or 18 hours out of the 24, and averaging from 90 to 120 miles per day. These facts speak for themselves. No service aboard-ship can approach that required of a motor for street car service, either in variation of speed or load, length of continuous duty, suddenness of shocks, strains and jars, unfavorable conditions of weather, streets, inaccessibility and narrowness of the space allowed, and lack of even a small amount

of attention. If we have a motor which is to-day successfully meeting and overcoming such conditions, is it unreasonable to predict that the same motor on board-ship, where every condition is vastly in its favor, will do as well and better? The street-car motors are put under a car within 6 in. of the ground, and the car is operated by an ignorant man who cannot even see his motors, who cares nothing about them, and who cannot tell one end of it from the other. These motors run, not by reason of any fostering care on the part of the motor man, but in spite of him.

Salt water has always been regarded as a hated enemy of the electric motor or dynamo, until within the past few months; its omnipresence aboard-ship would have been a serious objection to its use in many places. The same objection, however, had to be met and overcome in the street-car motor, and to-day we can actually soak an armature in a barrel of salt water, take it out, put it in a motor and run it. This is no idle boast, but a feat which has been actually accomplished. For some months the Sprague Company have been engaged in experimenting on a method of treating field coils and armatures with an insulating compound in such a manner as to render them impervious to water or acids. Recently an armature which had been put through the process was soaked for 24 hours in hydrant water. It was then taken out, measured, found to be sound in every respect, and then put into a barrel of salt water for 24 hours. At the expiration of this time it was taken out, put at once into a motor without a drying of any kind, and the motor was run for two hours on an overload varying from 25 to 50 per cent. above normal full load. No test could be more thorough or convincing, none more satisfactory to us. In future, all of our motors subjected to the influences of the weather or to any unusually unfavorable conditions will be subjected to this process.

The class of work to be done by motors aboard-ship may be divided generally as follows:

First Class.—Where the load varies, but speed of motor is constant—running lathes or drill presses, for example. For this work a differently wound, constant speed motor is most suitable. Such machines do not vary more than 2 per cent. in their speed from no load to full load. In some cases, where constancy of speed is not required within 5 or 10 per cent., a simple shunt machine will suffice.

Second Class.—Where it is desired to vary the load and speed only through a limited range—running ventilating fans, hoisting, and some pumping, for example. Here a cumulatively wound motor is desirable. In this case the field coil, in series with the armature, acts *with* the shunt coil in its magnetizing effect instead of against it, and a variation of from 15 to 30 per cent. in the speed can be obtained.

Third Class.—Where the load and speed vary widely, but where the motor is never without *some* load, as, for example, in steering, gun-training, and certain pumping. Here a plain series motor is the most suitable. The torque or turning moment of a motor varies directly as the product of the ampere turns in the fields and in the armature; in a series motor the same current passes through fields and armature; hence the torque varies as the *square* of the *current*. This means that in starting under a heavy load, or in moving the load slowly, a series-wound motor is capable of exerting an enormous torque for a short length of time.

These four types of motors will cover every class of work that an auxiliary engine on board-ship can be called upon to perform, and the motor will do it better in every instance than the steam-engine. The electric motor, as compared with the steam motor, is much more compact and lighter; simpler in construction, application, and operating; less noisy, cleaner, requires no skilled labor to operate it; is more reliable, more efficient, and *less* likely to get out of order. Every one of these points are points in its favor for ship use. Suppose the *Atlanta* had an electric motor instead of the steam-steering engine she has (which, by the way, takes up a whole compartment and makes the after part of the ward-room uncomfortably warm and noisy when in use). The motor would occupy about *one-fourth* the space, the steam and exhaust pipes would be replaced by the mains below the armored deck, and instead of the long line of shafting running from pilot-house to engine, a small controlling wire would run down from the conning tower through a small armored tube, and thence aft under the armored deck to the controlling switch of the motor. What a saving in first cost of installation, simplicity and ease of operation, and safety in time of action! Suppose the 8-in. gun-training engine, occupying a room by itself on the orlop-deck, was replaced by such a motor as the *Chicago* will have. The motor will be placed between the side brackets of the lower carriage and under the breech of the gun. It will be so geared that by throwing a single clutch either the motor or the hand-gear can be used. The long shafting running up through two decks is done away with, and the gun captain, with a simple lever in his hand, can train his gun with the greatest ease. I take pleasure in stating that the Sprague Company is now fitting such a motor (the first of its kind) to one of the 8-in. carriages of the *Chicago*. A smaller motor for elevating purposes is also being attached to the same carriage. At the same time, we have also put on board the *Atlanta* an ammunition-hoist motor to be used in whipping up the 6-in. and 8-in. shell, and having attached to it a very ingenious hand control. The same hoist can be used for hoisting ashes or for any general hoisting. A power-hoist is only advantageously substituted for hand-hoisting where weights lifted are comparatively heavy (100 lbs. or more), and where it is desired to handle them quickly with a lift of say 25 ft. or more. The principle of the floating lever as applied to steam ash-hoists is well understood. Briefly, the man handling the hoist must keep a small crank or wheel in motion in order to keep the engine moving. If he stops turning the wheel, the engine stops. If he reverses the wheel, the engine reverses. This control of the hoist becomes very important in hoisting loaded shell, powder, or high explosives. If a man is shot while hoisting, or if he becomes demoralized and lets go his hand-wheel or ceases to turn it, the engine must stop at once; otherwise, the shell might be detached from the whip and dropped down to the shell-room.

The new hand control carries out this principle fully. A man must turn a wheel in a certain direction to start the motor, and the speed increases as he increases the speed of rotation of his wheel. If he lets go the wheel, the motor is stopped. If he reverses it, the motor reverses. In testing the apparatus, it was at first found that when the current was cut off from the motor, the momentum of the armature carried it around for several revolutions, so that the weight being lifted or lowered was not brought to rest promptly. To remedy this, a magnetic brake has been applied to the armature shaft; the magnet coils of the brake (of very low resistance) are in series with the armature, and so long as a current is passing through the motor, the magnets are energized and the brake-shoes are held away from the shaft. When the current is shut off, a heavy spiral spring at once draws the brake-shoes together, and the armature is stopped.

These first two applications of motors on board-ship, the *Chicago's* gun-carriage motors and the *Atlanta's* shell-hoist, will doubtless receive much criticism in the service. Every new piece of mechanism does, and it is right and proper that they should receive such criticism, since naval officers know best what are the requirements and conditions on board-ship. It is only fair, however, that a new device should receive a full and thorough trial, and that when a criticism is made, there is a corresponding desire to improve. We already see where certain parts about the shot-hoist can be improved upon in any future orders, tending to simplify it and decrease the space occupied. It is the universal experience with all mechanical appliances, that successive improvements in them always mean a reduction in number of parts and simplifying of motions.

The chief object aimed at in applying the training and elevating motors to the 8-in. gun-carriage is to increase the speed of moving the gun, and to enable the gun captain to follow the object aimed at nearly or quite as readily as is now done with the Hotchkiss single-shot gun. A single universal movement lever controls both motors. The gun captain trains right or left by moving lever to right or left; if he wishes to raise or lower the breech, he raises or lowers the lever. A combined motion of the lever will

produce a combined motion of training and elevating or depressing. It would seem that with such a simple and complete control of his gun, a gun captain will be able to follow his target with almost, if not quite, the ease that he does with a 6-pounder Hotchkiss, since the motion of the gun is coincident with the motion of the man's hand, both in direction and in speed.

The application of a motor for steering purposes deserves special mention. It has been suggested to have a motor to operate the *valve* of the steam steerer only. While this would do away with the clumsy mechanical devices now necessary to transmit motion from the hand-wheel to the engine, it is only a step in the right direction. The moving of the *tiller itself* should be accomplished by a motor. The system would then be a completed whole, and there would be a large saving in space, weight, noise, and heat. The same hand control, already mentioned in connection with the shell-hoist, would be most suitable for steering purposes. The motor moving the tiller follows the motion of the wheel in the hands of the helmsman, both in direction and speed. If he stops turning his wheel, the tiller stops in whatever position it may then occupy. This is analogous to the motion of the present steam-steering engine. A pointer on the standard supporting the wheel indicates at any time the position of the tiller. It will be of interest to naval officers to know that the methods above described for adapting the electric motor to the handling of guns, steering, and hoisting, are themselves the design of a naval officer, Lieutenant Bradley A. Fiske.

It will be seen from the foregoing remarks, that in introducing the motor on board-ship, the navy will simply be following the experience and practice of commercial life, and there can be no reasonable doubt that the same advantages which have followed the introduction of the motor on shore will follow with even greater force its introduction on shipboard.

ELECTRIC RANGE-FINDER.

One of the latest applications of electricity to nautical and military purposes is the range-finder, also invented by Lieutenant Fiske. It is impossible at present to obtain the details of the apparatus, but it is known to consist of an electrical device by means of which the exact position of two telescopes at the ends of a base line of known length is automatically given. As applied to the *Chicago* and the *Boston*, the Bureau of Ordnance has insisted that the range-finder shall give accurate indications of the distance of objects on any and all bearings, and that it shall not interfere in any way with the working of the ship or any part of its armament or equipment. It is expected that this invention will increase the ease and value of fleet evolutions, since every ship will have absolute knowledge of her distance from the others; and that it will lessen the dangers of coasting, since a vessel can plot her exact position as often as desired, having the means at hand for ascertaining both her distance and her bearing from any landmark, buoy, or lightship within sight. As an example of the accuracy of the instrument, it may be stated that the average error of 20 observations, half by night and half by day, was less than 1 per cent., the ranges varying from 500 yards to 2,600 yards, the instrument being the first one constructed, and necessarily crude.

SIGNALING BY ELECTRICITY.

One of the most serious problems to confront the commander-in-chief of a modern fleet or squadron is the transmission of signals in time of action to the vessels under his command. The enormous powder charges used in all modern high-power guns create such a smoke after the first round is fired that signaling by flags, semaphores, etc., is out of the question. It has been suggested that it is a perfectly feasible plan to communicate between vessels by means of electricity, either by induction or by the direct action of an electric current. Two years ago, while attached to the *Atlanta*, I assisted Lieutenant Fiske in some interesting experiments of this nature. While the results obtained were not as successful in point of distance as we had expected, we did transmit signals from the *Atlanta*, then lying at the dock (New York Navy Yard), to the tug *Nina*, stationed in the Wallabout, there being no wire connection of any kind between the two vessels. The man receiving the signals had a pair of telephones at his ears, and the make and break of an ordinary telegraph key in circuit with the *Atlanta's* dynamo was distinctly heard. The results obtained would, at least, seem to warrant further experimenting in the same direction. A man receiving such messages by telephone could be stationed on the orlop or berth-deck by himself, where he could be quiet, and he could then transmit them by speaking-tube or telephone to the commanding officer.

Night signaling is now extensively done by electricity. The incandescent light offers a ready substitute for the torch or signal lantern in signaling between vessels that are within sight of one another. Devices for signaling by the incandescent lamp have already been devised and described. The search-lights, however, offer a much more comprehensive system of signaling. Their powerful beam of light, when thrown into the sky, can be seen 20 or 30 miles away, and by having a quick-moving shutter or screen to cut off the light, the regular Morse code can readily be used in transmitting signals. Vessels separated by high land have thus communicated with each other and with forces on shore.

ELECTRIC ANNUNCIATORS, BELLS, GUN-FIRING CIRCUITS, ETC.

Electric communicators, bells, etc., have now reached such perfection and are so familiar to all that they need no description. They are largely used on all of our new vessels. The firing of the heavy guns by electricity, however, is a matter that should receive careful attention. Some experiments have already been made on board our older vessels, and new designs have been prepared for the Bureau of Ordnance for our new vessels which embody many improvements over the old system. While it may be true that the guns will ordinarily be fired by the gun captains, the commanding officer may nevertheless want control of the battery at a critical moment, and *this* is the time when the firing circuit will come in. It would certainly seem that the comparatively small outlay necessary for its installation would be well compensated for at such a time. Moreover, the gun captain himself should be able to fire his gun by electricity. An astronomer, when using a transmit instrument, records the transit of the body observed on the chronograph by pressing an electric button. He uses electricity because he has got to *record* simultaneously with the transit of the body across the wires in the field of vision. Just so the gun captain should be able to press a key and fire his gun the *instant* his sights come on the object aimed at, and this can be accomplished by electricity better than by any other known method.

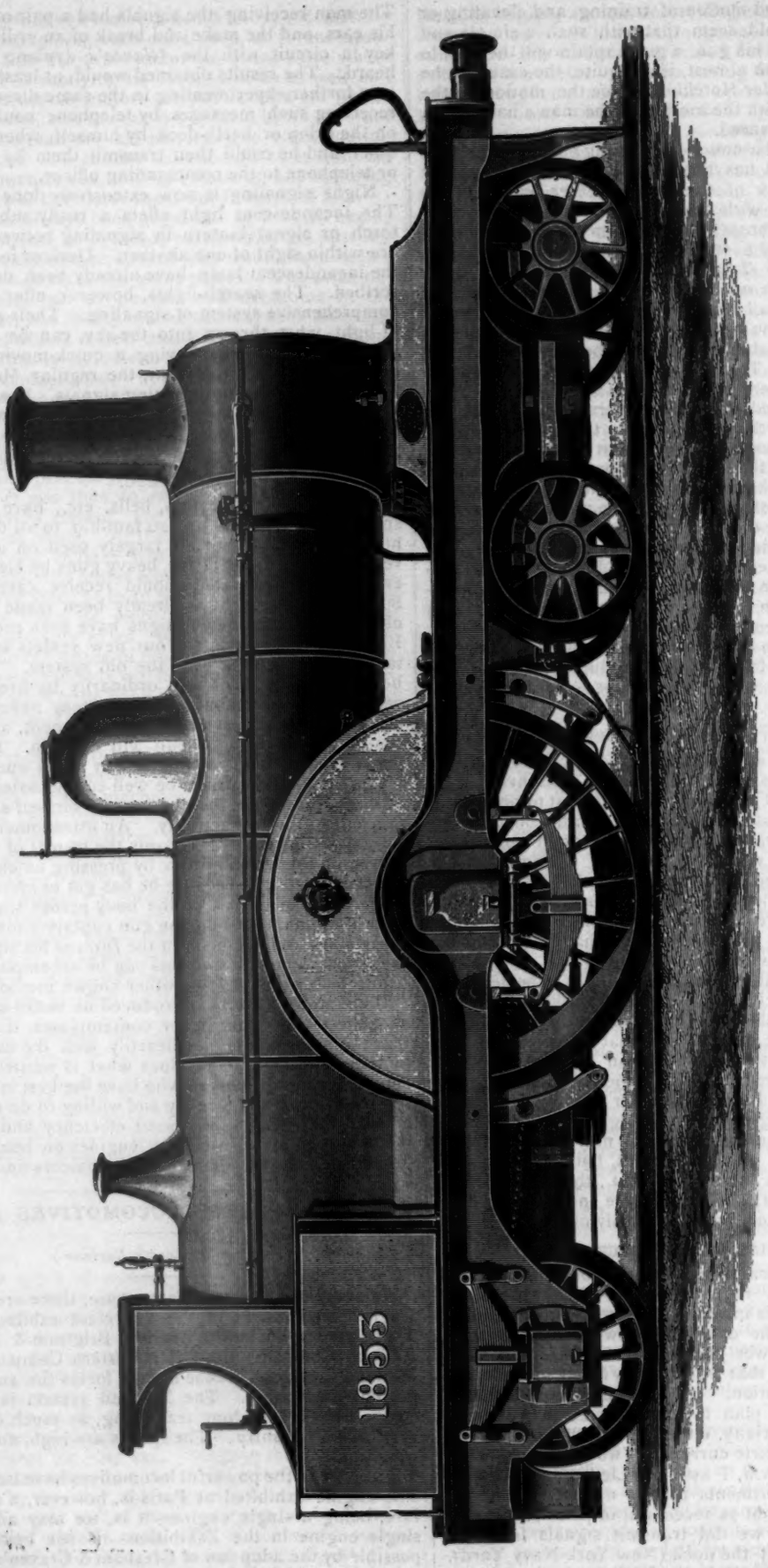
If electricity is to be introduced on board our war ships as generally as this paper contemplates, it is necessary that the Navy co-operate heartily with the manufacturers in their endeavor to produce what is wanted, and I feel confident that all officers who have the best interests of the service at heart stand ready and willing to do so. The use of electricity means increased efficiency and economy in the operation of all auxiliary engines on board-ship, and greater health and comfort for the officers and men.

ENGLISH EXPRESS LOCOMOTIVES AT PARIS.

(From the London *Engineer*.)

As many of our readers are aware, there are only three English locomotives of the first class exhibited at Paris. These are shown by the London, Brighton & South Coast Railway Company, the South-Eastern Company, and the Midland Company, whose engine forms the subject of our present illustration. The Midland system is one of the heaviest in the kingdom, traversing, as much of it does, a very difficult country. The speeds are high, and the trains weighty.

Hitherto all the powerful locomotives have been coupled. The engine exhibited at Paris is, however, a new departure, being a single engine—it is, we may add, the only single engine in the Exhibition—its use being rendered possible by the adoption of Gresham & Craven's sand-blast system, by which a fine spray of sand is blown under the treads of the driving-wheels by jets of steam.



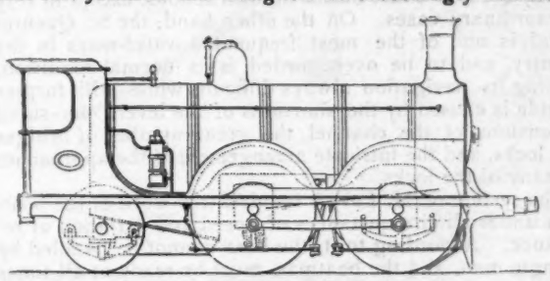
EXPRESS PASSENGER LOCOMOTIVE MIDLAND RAILWAY, ENGLAND.

SAMUEL W. JOHNSON, ENGINEER, DERBY, ENGLAND.

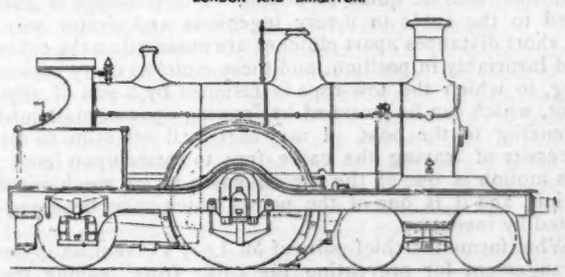
The following tabular statement gives particulars and dimensions of the engine and tender:

	Ft.	In.
Diameter of cylinders	1	6½
Stroke	2	2
Lap of valve	0	1
Lead of valve in full gear	0	0⅛ full.
Distance of cylinders apart	2	4
Diameter of driving-wheels	7	6
" bogie "	3	6
" trailing "	4	4
Bogie center to driving center	10	0½
Driving center to trailing center	8	9
Bogie wheel centers	6	0
Wheel base, engine and tender	43	2¾
Working pressure	160 lbs.	
Length of boiler barrel	10 ft. 4 in.	
Mean diameter outside barrel	4 ft. 2 in.	
Fire-box, outside length	6 ft. 6 in.	
Number of tubes	244	
Diameter of tubes	242 1⅝ in. diam.	
	2 1⅛ in. "	
Heating surface, tubes	1,123	5 sq. ft.
" " fire-box	117	"
Total heating surface	1,240.5	sq. ft.
Grate area	19	6 "
Engine weight, working order	43 tons.	
Weight on driving-wheels	17 tons 10 cwt.	
Tender, water capacity	3,250 galls.	
" coal "	3½ tons.	
" weight, working order	30 tons.	
Average gross load, London to Nottingham	170 to 215 tons.	
Equivalent vehicles	9 to 13 carriages.	
Booked speed per hour	53⅜ miles.	
Coal consumed per mile	20 to 23 lbs.	
Longest run without stop	124 miles.	

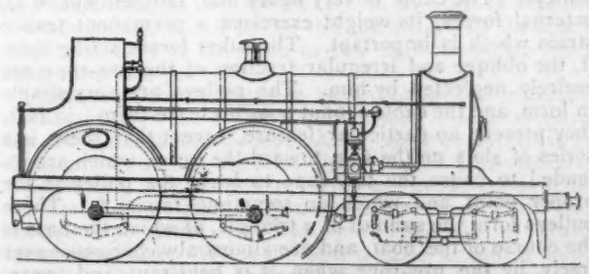
A glance at our engraving is quite sufficient to show that Mr. Johnson has designed an exceedingly handsome



LONDON AND BRIGHTON.



MIDLAND.



SOUTH-EASTERN.

engine; and the finish and workmanship generally are of the highest class. The engine is painted the beautiful dark red which Mr. Johnson has introduced with so much benefit to the pockets of the shareholders; and the large brass driving axle-boxes have an admirable effect.

The engine was designed in 1887, and there are now at work or in course of construction 15 of the class. In 1863 the prevailing type on the Midland Railway was a six-wheeled single engine. In the engine exhibited the boiler is of steel; the barrel is composed of three rings put together telescopic fashion. The side frames approach each other in front to give room for the bogie. This is of the normal Midland type, with inside frames and balance beams. It has a horizontal traverse of about 1½ in., controlled by lateral spiral springs. The spectacle plate is of cast steel. The valve-gear is of the ordinary Stephenson's link type. Our contemporary, *Le Genie Civil*, publishes three outline engravings which we reproduce here, as they show very clearly the principal features of the three English locomotives.

CABLE TOWING ON CANALS.

(M. le Chatelier in the *Revue Scientifique*.)

THE International Congress on Water-ways, which met in Paris in July, and which was attended by many French and foreign engineers, paid particular attention to the question of Cable Towing.

French readers know that M. Levy and M. Oriolle have recently attempted definite solutions of this important problem, which each has worked out after his own method. It is to be hoped that public attention will be directed to these attempts, which are full of promise, and for that reason we have undertaken to explain both, and to see how far the plans which were discussed in the Congress answer the needs of inland navigation.

M. Derome, Chief Engineer of the Department of Roads and Bridges at Compiegne, has presented to the Congress a valuable report on the actual methods of towing boats on canals. At least four-fifths of the tonnage of the French system of internal navigation is towed by animal power, the horses or mules being furnished by the farmers who live near the canal, or by contractors who have an organized service for that purpose. On either plan this method of towing presents inconveniences inherent to the use of living motors. The animal consumes as much when at rest as when at work, and its use will only pay when its daily work is practically equal to the proportion of the average yearly work which can be exacted from it. It is also true that the effective work of the horses used for towing cannot exceed a certain amount, and that the force is insufficient to meet the demand as soon as the movement of traffic passes the average limit. The result is that the boats on the canal must wait their turn for towing; the length of the trip becomes uncertain; the requirements of commerce are not properly met; and there is a tendency to raise the rates of freight. Moreover, the movement of boats is irregular; the locks are sometimes idle, because there are no boats ready to pass through, and again they are overcrowded and cannot pass the boats fast enough; from this there results an expensive delay of traffic.

To secure a regular movement of boats on our water-ways, is to increase the tonnage which they can carry; to diminish delay, and to enable the boats to increase the number of trips which they can make in a year. This is the object at which engineers have aimed in endeavoring to replace animal towing by some method of mechanical towing.

The problem is a serious one; and the object is really to place the canals on the level with other industrial enterprises; to do for them what the locomotive has done for the railroad.

M. Derome has described the different plans thus far tried for mechanical towing, by locomotives and other methods. Very much depends on the cost of the work, since the present plan is very cheap, the cost being somewhat less than 0.1 cent per ton per mile on the average. Cable towing promises a still further reduction, and for this reason it deserves serious attention.

This term "Cable Towing," adopted by the Congress, defines the system very nearly. A fixed motor drives an endless cable supported at proper distances by pulleys; this cable runs along either bank of the canal in opposite directions. Each boat is attached to this cable on one side or the other, according to the direction in which it is go-

ing, and can be cut loose at will. The abstract idea is extremely simple, but the conditions arising in practice bring in many difficult complications.

Suppose a boat on the canal at rest and weighing, say 400 tons with its load. The cable which should draw it is part of a circuit some 10 miles in length; it weighs 100 tons and moves at a speed of 200 ft. per minute. Such heavy weights cannot possibly communicate their respective speeds to each other at once without developing an enormous resistance for a short time; but the connection between the boat and the cable is made by a rope which must be comparatively light and weak. From this arises the first difficulty: *The boat must be put in motion gradually.*

When the boat has acquired the same speed as the cable, it must be kept away from the bank and near the center of the canal, where the greatest depth of water will be found under its keel. It is, therefore, running at a certain distance, say from 35 to 40 ft., from the cable; the tow-rope must be two or three times that length, and will therefore act on the cable in an oblique direction, and will tend to pull it off the carrying pulleys. It will be seen that the form of these pulleys may oppose this tendency, but when the point where the tow-rope is secured to the cable passes over a pulley, special precautions must be taken to prevent this tow-rope when it leaves the pulley from drawing the cable after it. Hence arises the second necessity: *The cable must be under no danger of leaving the pulleys.*

Another point to be considered is the constant variation in the power needed to move the boat. It has been found almost impossible to work out any definite formula, but if we assume that the average power needed to move a boat of 400 tons at a rate of 200 ft. per minute, is about 880 lbs., it will be found that in practice it may vary from 0 to 2,200 lbs. The wind, the passing of a boat moving in the opposite direction, the passing through a narrow section of the canal, etc., are sufficient causes of this variation; but there is another, less perceptible and consequently more dangerous. In passing a boat from one level on the canal to another, it is necessary to draw from the upper level into the lower a certain volume of water, and this for a time lowers the water in the upper level, and raises that in the lower level by several inches. The opening and closing of the lock occupies only a very short time, but a much longer time is required to produce the effect on the two levels of the canal. From this there results an action which has never been accurately observed or formulated, and which is, on a small scale, very similar to that of the tidal waves found at the mouths of certain rivers. It is caused by the difference between the rapid rising of the tide in the open sea and its comparatively slow action in the narrow channel of the river. On the levels of the canal no current is visible to the eye, but there is a slight wave which is well known to the boatmen, and which on very short levels may pass back and forth several times from one end to the other. If this wave strikes a moving boat, either in front or from the rear, the resistance of the boat is either increased or diminished by a sensible fraction of its total amount.

From all these causes—and, perhaps, from some others—a boat moving through the canal at a constant speed exercises on the tow-rope a force which is incessantly varying in degree, and if we observe this rope from the boat we will see, perhaps with some surprise, a constant change in its tension. With a mechanical motor, account must be taken of these changes, to which an animal motor—a horse, for instance—soon learns by instinct to accommodate itself.

This is not all. Wherever there is a water channel there are obstructions and irregularities in the bottom, and if they do not exist in the first place, the carelessness or the lack of common sense—if such a term may be used without insulting them—of the boatmen would soon make them. When a boat strikes such an obstruction, the horse which draws it will fall back and perhaps tumble into the water; but to that the animal is accustomed and will speedily recover itself. An engine or any other mechanical device would not know how to save itself, and some protection from accident must be provided. Hence arises the third principle: *The variations in resistance to traction must not affect too much the towing system.*

We now have the general conditions of the problem; but in applying these there will be found many others which will be constantly varied by the local circumstances of the case. The banks of a canal, with the interruptions made by bridges and by the walls of the locks, show both in plan and elevation a constantly changing form, which the cable must follow, and instead of forming two straight parallel lines, it will present a number of angles which may be in a geometrical plane anywhere between the horizontal and the vertical. Under all these conditions the cable must remain *strictly underailable.*

The solutions of this problem worked out by M. Levy and by M. Oriolle are radically different. It is true, however, that the local conditions under which each one worked were also very different.

The place where M. Levy made his experiments, and where he claimed—perhaps somewhat too soon—the honor of solving the problem, is the Junction Canal between the Seine and the Maine. In consequence of its position, this canal is only used by the boats running upon those rivers, which are well equipped, and carry more than one man on board. These men are accustomed to careful management of the boats, and especially to the operation of attaching a boat to a large tow while in motion.

The St. Quentin Canal, where M. Oriolle made his experiments, is part of the main line of navigation between Paris and Belgium. The boatmen on this canal are a peculiar class, each man generally owning a single boat upon which he lives with his family. He is accustomed to the common navigation of the canal, not always very skilled in his business, and so much afraid of river navigation that when he leaves the canal for the river, he often puts his boat in charge of a pilot, who, perhaps, knows no more about it than himself. It may be added that the Junction Canal has a large section; its locks are considerably over the normal size, and the traffic upon it is not sufficiently great to cause blocks or obstructions, except in very extraordinary cases. On the other hand, the St. Quentin Canal is one of the most frequented water-ways in the country, and to be overcrowded is its normal condition, making its navigation always difficult, while still further trouble is caused by the shortness of the levels, the small dimensions of the channel, the great number of bridges and locks, and the intricate arrangement of the approaches to many of the locks.

The system of M. Levy * requires the work of the boatman under all circumstances of speed and variation of resistance. According to it, the boat cannot be handled by a single man, and the boatman must be ready at all times and must also be quick in action. The tow-rope is fastened to the cable in a very ingenious and simple way. At short distances apart clutches are mounted on the cable and invariably in position, and these clutches carry each a ring, to which the tow-rope is fastened by a sort of slip-knot, which can be loosened by drawing upon a small cord extending to the boat. I may here call attention to the necessity of leaving the cable free to rotate upon itself; this motion is one of the consequences of its mechanical action, and it is one of the points which have been neglected by inventors.

What forms the chief point of M. Levy's invention is the arrangement for preventing the cable from leaving the pulleys. The cable is very heavy and, independent of all external forces, its weight exercises a permanent tensile strain which is important. The other forces acting upon it, the oblique and irregular traction of the tow-rope are entirely neglected by him. The pulleys are very simple in form, and the cable cannot possibly leave them; in fact, they present no particular feature, except that there is a series of slots on the side toward the canal, which are intended to cause the tow-rope to leave the pulley at the proper point, and which do sometimes assist it. These pulleys form the summit of a triangle, of which the base is the course of the boat, and are almost always passed over freely by the tow-rope when it is held taut, and consequently apt to draw off without difficulty. They are mounted in a plane inclined from the horizontal toward the canal, and the slots have a wide opening. In this way

* M. Levy's system was described and illustrated in the JOURNAL for April, 1889, page 167.

one difficulty has been overcome in a very ingenious way, but not without changing somewhat the line of the cable.

Many members of the Congress visited this canal and observed its work, and they have made some observations, among which are the following :

It seemed to them, in the first place, that the necessity of attaching the tow-rope at certain fixed points on the cable, and of detaching it completely when it is desired to stop the boat, makes it necessary to keep the cable very low—that is, at such a point that it can always be reached by the boatman's hand, and that this position gives room for accidents to persons. It also seemed to them that the importance attached to the work of the boatman and the necessity for him to step from the boat to the tow-path whenever the tow-rope was to be loosed or attached required considerable extra work, and made it imperatively necessary that there should be two men on the boat, one to steer and the other to watch the attachment. This probably would not be any objection on the canal in question, where the boats coming from the river and returning to it are well manned ; but it might be of importance on other canals. Some doubt was expressed as to the durability of the cable, owing to the high degree of tension to which it is submitted, but the care with which the details of the work have been carried out received much praise.

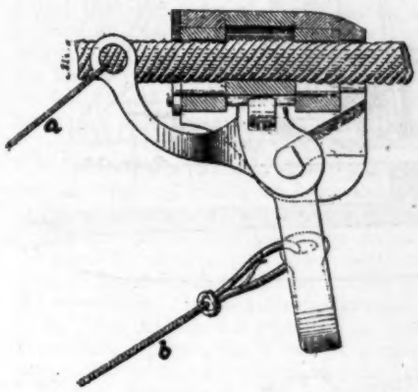


Fig. 1.

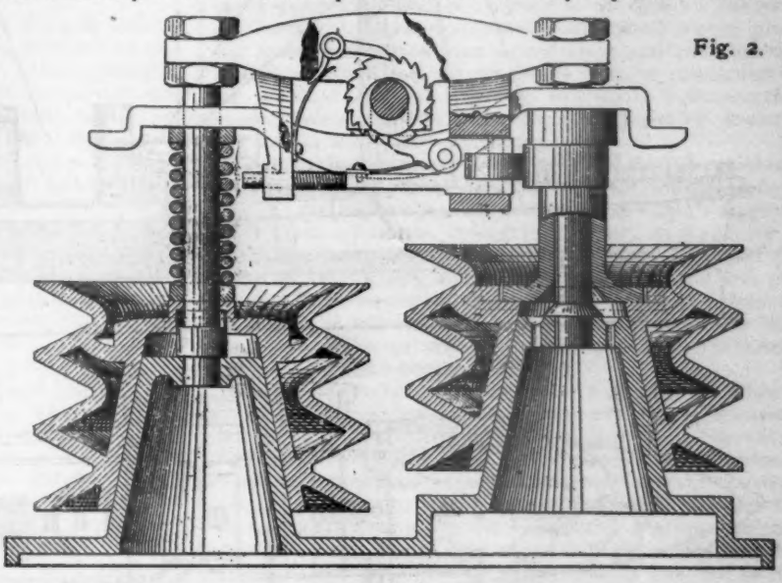


Fig. 2.

It seems that M. Oriolle desired in all points to make a strong contrast between his arrangement and those of M. Levy. His cable is as light and subjected to as little tension as possible, and here there is a considerable advantage in the first cost. The point which allowed him to diminish the permanent tension is the very excellent idea of suspending his pulleys from above by a sort of swinging hanger or frame, instead of a fixed support—thus allowing them to follow somewhat the movement of the cable. Instead of commanding the motion of the cable, the pulleys follow it, and the tendency to derailment is thus largely reduced, and what remains is done away with by a guide attached to each pulley, which forces the tow-rope and the clutch which holds it to the cable to run over the pulley in the most favorable position.

Aside from these details of construction, the originality of the idea is in the method of attaching the tow-rope to the cable and to the pulley. After many experiments M. Oriolle has reached the form shown in the accompanying illustrations, figs. 1 and 2, which are necessary to make the description clear. Fig. 1 shows the clutch which fixes the tow-rope to the cable and by which it can be thrown loose altogether. When the boat is to be attached, an attendant puts a clutch upon the cable, and fixes the tow-rope *b* to one of the levers ; to the other he attaches a cord, *a*. It will be seen from the drawing that the boatman can : 1. By holding the ends of the tow-rope *b* make the clutch grip the cable and draw the tow along, the rotary movement of the cable remaining possible. 2. By drawing on the cord *a* break the connection and hold the clutch in place, the cable passing through it without drawing it along. The clutch is composed of an iron box or case in which are three rings. The lever with two arms is carried upon a lug attached to the clutch ; the tow-rope and the cord are fixed, one to each arm of the lever. The working of this clutch is very simple. The tension of the tow-rope causes a roller to bear upon the middle ring and holds the cable between the two outer rings with a force proportioned to the tension. If the cord is drawn, acting upon the other arm of the lever, the rings are loosened and the cable slips through them without moving the clutch.

With this arrangement there is no necessity of reaching the clutch by hand, and a boat once attached to it can be started and stopped at will, without the boatman having to step on the tow-path, and without his having to wait for the passage of another clutch to start the boat again. This condition is indispensable on the St. Quentin Canal, where navigation, in consequence of the many delays and the number of locks, is a constant succession of stops and starts.

The tow-rope attachment is a very important invention, and enables the boatman to handle the rope without difficulty and very quickly. This arrangement is shown in fig. 2, and consists of two cast-iron grooved pulleys, each carried upon a conical pivot, also of cast iron, and made in one piece with the bed-plate by it which is fastened to the deck. The tow-rope is rolled around these pulleys, and when the boat is fastened to the cable, it moves around them, causing them to turn with it. In this movement the pulleys are forced down upon the pivots, the pressure gradually increasing at each turn. After nine revolutions, the pressure is so great that the pulleys cease to turn under the ordinary strain of traction ; and this strain, which at the start is nothing, thus gradually attains the maximum necessary for towing the boat at full speed. In this way a sudden strain on the cable is avoided, and one of the objects which we have already noted is secured. As a further security, the cord which loosens the clutch is fixed to a lever forming part of this towing-post. If for any reason the strain is suddenly increased and passes the calculated maximum, the pulleys begin to turn again, and the cord, acting upon the lever, loosens the clutch, so that the pulleys are once more set free, and can turn, allowing the tow-rope to pass through them. In the case actually in trial, the maximum strain to which the pulleys are adjusted is fixed at about 990 lbs.

This arrangement was very much admired by the members of the Congress who have seen it, and by its use, it is believed that several of the objections urged to cable towing will be entirely obviated. Instead of being obliged to execute a difficult and sometimes dangerous operation, the work of the boatman becomes entirely easy and simple, while when the boat meets with obstruction, the action is

quick and automatic, and does not depend upon the skill or promptness of the attendant.

There is no hesitation in saying, then, that the Oriolle system fulfills the conditions of the problem, while the Levy system is wanting in certain points, although it is, perhaps, well adapted to the particular circumstances under which it has been tried. In other words, one of these systems can be applied only under peculiar conditions, while the other has a very much larger future before it.

These improvements must be regarded with great satisfaction, because it has long been evident to engineers that some form of mechanical traction is necessary to enable us to realize the full advantages of the canal system.

Fig. 1.

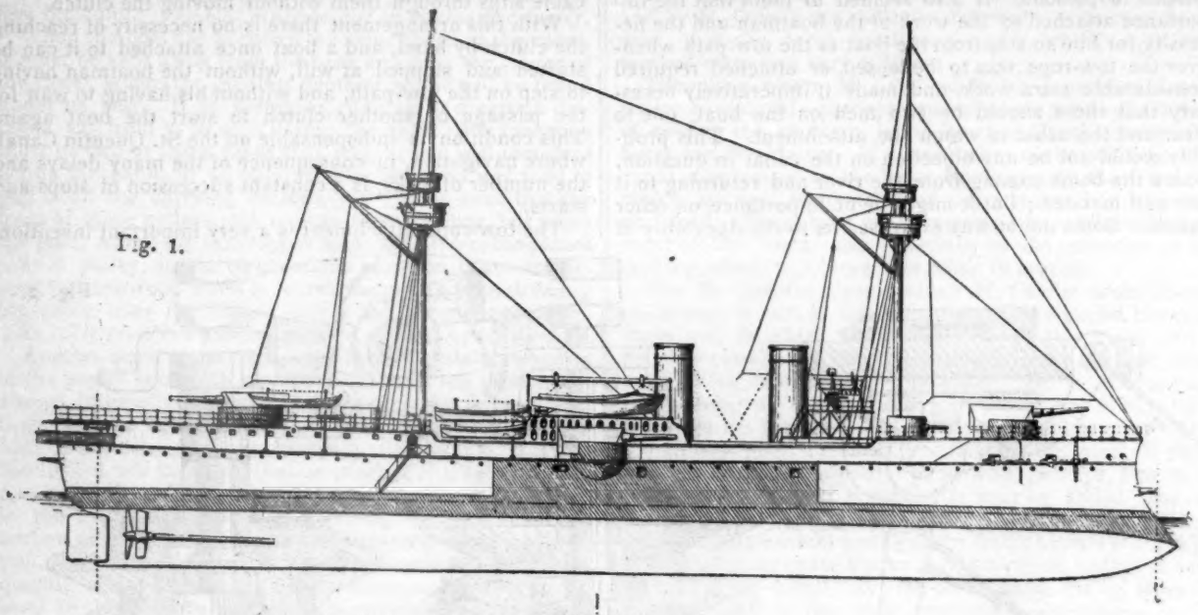
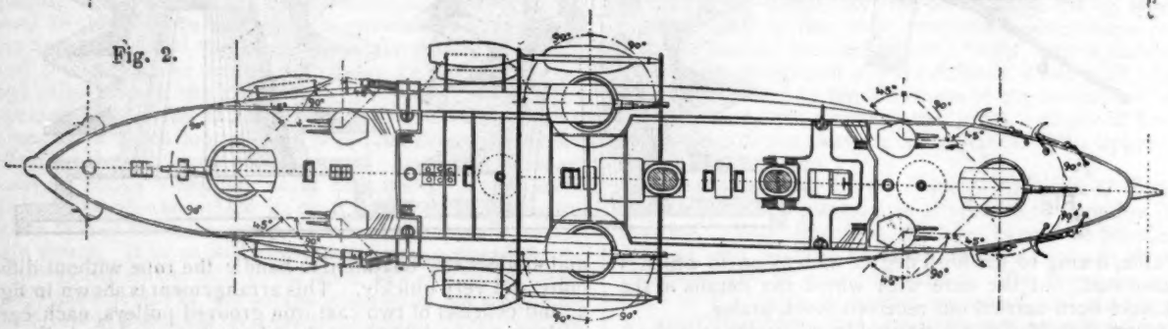


Fig. 2.



A NEW CHILIAN BATTLE-SHIP.

SOME two years ago the Chilian Government appointed a board of naval officers to contract for several new vessels for its Navy. Sir Edward Reed, the well-known English naval architect, was chosen as Consulting Engineer for this board.

Under this action contracts have already been let in France for two cruisers of 2,000 tons displacement, and in England for two torpedo-chasers of 730 tons displacement. More recently bids were asked for an armored battle-ship, the bidders to furnish plans also, only the general plan being given by the board.

The conditions were that the ship should be 6,000 tons displacement, or somewhat over; should have belt-armor of Creusot steel; should carry an armament of four 24-cm. (9.45-in.) and six 15-cm. (5.91-in.) guns; should be capable of making 17 knots an hour with natural draft and 19 knots with forced draft, and should have a cruising limit, at 10 knots an hour, of not less than 7,000 knots, with a normal coal supply.

Twelve bids were received, seven from English, three from French, and two from German firms. The bids ranged from $1,900,000 to $2,300,000, and the contract has been let to the French Société des Forges et Chantiers de la Mediterranée, the price to be $1,904,000.

This firm was the only one whose plans provided for a central armored casemate extending above the armored belt to the upper deck, and protecting the machinery and boilers, an arrangement which has been very generally adopted for vessels of a similar class in the French Navy.

Its plans also provided for the substitution of eight 12-cm. (4.72-in.) rapid-fire guns for the six 15-cm. guns, thereby somewhat increasing the weight of the battery, and very much increasing its fighting efficiency.

A further detail of this plan was the arrangement of cells or compartments between the lower deck and the armored deck, to increase the buoyancy of the ship.

The armored belt is 2.10 m. (6.89 ft.) wide and its maximum thickness is 300 mm. (11.81 in.). The central casemate or citadel is 41 m. (134.5 ft.) long and 18.50 m. (60.68 ft.) in width.

The general dimensions of the ship are as follows:

Length between perpendiculars	100.00 meters	(328.00 ft.).
Breadth over armor	18.50 "	(60.68 ")
Depth from upper deck	10.64 "	(34.90 ")
Average draft	6.65 "	(21.81 ")
Immersed cross-section	109 50 sq. m.	(1,179 sq. ft.).
Displacement at average draft		6,901 tons.

Distribution of weight:

Hull	2,240 tons.
Armor, including deck-plating	2,108 "
Boilers and machinery	1,145 "
Guns and ammunition	665 "
Ordinary equipment	160 "
Crew and stores	183 "
Normal coal supply	400 "
Total	6,901 "

These plans differed somewhat from the dimensions of the plan prepared by the Consulting Engineer, but the modifications proved acceptable to the board, and the bid was, as stated above, accepted in preference to any of the

others, although it was not the lowest. The central casemate was considered better, in principle and detail, than the two turrets which were provided for in some of the plans.

In the accompanying illustrations, for which we are indebted to the *Mittheilungen aus dem Gebiete des Seewesens*, fig. 1 is an elevation and fig. 2 a deck plan of the ship, showing the general arrangement of the armor and guns.

From the drawings and description, it appears that our South American neighbor will, when this vessel is finished, add to its Navy a battle-ship formidable for its speed and for its offensive and defensive powers.

THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(Copyright, 1889, by M. N. Forney.)

I.—EARLY EXPERIMENTS.

Although the modern battle between the gun and the armor-plate began at Kinburn, in 1855, it must not be supposed that the idea of using metal, or other protection against an enemy's missiles, had not been considered long before. In fact, as early as when men first took to the sea and began to settle their disputes in naval encounters, we find record of a resort to artificial protection for ships' bulwarks and the men who were to fight behind them. When the Mediterranean buccaneer fastened leather or raw-hides along the side of his galley, it was the first resort to armor of which we have knowledge, and the marauding Normans in hanging their bucklers along the sides of their ships accomplished the same object. Later, in the twelfth century, these same enterprising Normans are said to have built war vessels with a belt of iron above the water-line. In the sixteenth century, when the Knights of St. John furnished a war-ship to Admiral Doria for his expedition against the Tunisian pirates, we read that it was plated with lead to keep out the barbarian shot.

It was, however, in the famous three years' siege of Gibraltar, made memorable by the heroic defence of Governor Elliot and his English garrison against the combined forces and fleets of France and Spain, that we find the first appearance of anything that would resemble a modern ironclad. Under the direction of the French engineer, d'Arçon, ten floating batteries had been constructed, the roofs of which were bomb-proof and the sides protected with 6 ft. of hard wood, reinforced by cork, hides, and bars of iron, and supplied with more than 200 of the heaviest guns. One can imagine that when on one September day in 1782, these marine monstrosities appeared before the eyes of the starving garrison, backed by the combined French and Spanish fleets, and opened their murderous cannonade, the English cannoneers went to their guns with but faint hope of victory. For hours their shot rattled harmlessly against the decks and sides of these uncouth adversaries, and not until by a happy inspiration hot shot were resorted to did it seem possible long to endure the terrible rain of missiles poured into the British batteries. But wood and iron could not withstand red-hot cannon-balls, and one by one the dreaded ironclads caught fire, drifted out of the fight, and at last blew up, until nine out of the ten had succumbed to flames and powder, and save a few hundred survivors picked up by English boats, their entire crews perished.

This was a brave beginning, but an unfortunate one for the ironclad, and for more than half a century no pronounced effort was made to repeat the experiment.

In discussing the question of armor, it is understood that the term, as usually employed, refers to any metallic protection superimposed upon the original structure, whether that structure be the side of a ship or the walls of a fort. In a more general way it is used to designate any artificial protection, even when not of metal, and also, as in the case of land defenses, when the whole structure is of metal.

The havoc wrought at close quarters on shipboard by the inferior ordnance of the seventeenth and eighteenth centuries, and the experience gained on land in countless sieges during the same period, must have made apparent the advantage of something in the way of extra protection to ship and fortress. On land the difficulty was met by an increase in the thickness of wall and in the quality of the material employed, but on the sea, so long as the solid shot was the only projectile employed, the sailor was content to take his chances behind his wall of oak. When, however, about the end of the first quarter of the present century General Paixhans discovered a way to fire hollow projectiles containing a bursting charge from ordinary guns, the necessity for this protection became obvious, and could no longer be neglected. It should be said here that up to this time the use of shell, or bombs, as they were called, was restricted to mortars, or short pieces, where the projectile could be placed in the gun by hand.

Against walls of good masonry the new missile was found to be inferior to solid shot, so the introduction of the shell-gun had little significance to the engineer, who went on building his forts upon the old lines, simply increasing the thickness of his granite walls to meet the increased power of the attack. His awakening was to come some years later with the advent of the rifle.* The man on shipboard, however, realized that a shell would prove far more destructive than round shot, and attention was naturally turned toward providing metallic protection for his wooden bulwarks. Before this could take practical shape it was necessary to ascertain the resisting power of the metals to artillery projectiles.

The first systematic attempt to ascertain this resistance was begun in 1827 at Woolwich, in England, by General Ford of the Royal Engineers. He constructed a target of two layers of square wrought iron bars, aggregating 2¾ in. in thickness, the outer layer horizontal, the inner one vertical. A backing of 7 ft. of Aberdeen granite was provided. This target he attacked with solid shot from 24-pounders at 600 yards' range. Twenty shots were sufficient to so displace and break it up that the experiments were for the time being abandoned.

The subject, however, still held a prominent place in the minds of thinking military men and others interested in military matters, and in 1841 Mr. Robert L. Stevens, of Hoboken, N. J., who, with his brother, was endeavoring to obtain assistance from the Government in the construction of an iron-protected floating battery, in a letter to a Government Committee on Coast and Harbor Defense, reported as the result of a series of experiments they had made, that a thickness of metal of from one-half to two-thirds the diameter of a shot, if inclined at an angle of 45°, was sufficient to resist penetration; and also, that wood had to be 16 times the thickness of iron to offer the same resistance. Mr. Stevens may be said to have inherited from his father the idea of a floating ironclad battery, and in the end sank a fortune in attempting to carry it out.

In 1846 experiments with armor were resumed in England, and may be said to have been continued almost without interruption to the present day. The first experiment was with a ⅝-in. rolled wrought iron plate and a 32-pounder smooth-bore gun. The plate proved wholly inadequate to the requirements, and an increase in thickness naturally followed. Without going into the details of the many experiments carried on during the 10 years immediately following, it will be sufficient to say that at the end of this period 4½ in. had been reached. The plate of this epoch was not solid, but made up of a number of thinner plates each about 1 in. in thickness and bolted together. It was found to resist fairly well the attack of guns up to the 68-pounder at moderate ranges. In all of these experiments cast iron projectiles and plates of rolled wrought iron were used.

In the United States, from 1853 to 1855, General Totten, of the Engineers, conducted a series of experiments to test the value of iron plates as a protection for the masonry walls of fortifications. Rifled cannon were at this time making their appearance, and the engineer had awakened

* The doom of masonry as a material for fortifications was sounded at the siege of Fort Pulaski in 1862, where rifled guns of very moderate power breached walls of masonry at the distance of a mile or more. This lesson was confirmed in the following year, where rifled ordnance did very effective work against the walls of Fort Sumter at a range of 4,000 yards and over.

to the fact that walls of brick and granite could no longer be implicitly relied upon to withstand the new weapons.

In these experiments targets were constructed of granite, brickwork, hydraulic cement, and concretes of various kinds. These were covered with wrought iron plates of from ½ in. to 8 in. in thickness, and fired at with different projectiles, from grape-shot up to the heaviest then in use. Two important facts were demonstrated by these experiments; one, that masonry was by no means a good backing for iron armor; that it was broken up and disintegrated by the blows of the projectile, even where the plate itself was comparatively uninjured. This fact was more completely emphasized in later experiments, when, after the introduction of rifled projectiles, the energy of impact was greatly increased; the other fact demonstrated was that a single solid plate of any given thickness offered much greater resistance than a laminated one. Brickwork and some of the concretes were found to resist disintegration much better than granite. Experiments in England of a little later date demonstrated the same facts, both as regards masonry backing and the superiority of solid over the built-up armor plate. The superiority of wrought iron projectiles over those of cast iron was also thoroughly demonstrated both in England and in Russia.

The Crimean war not only witnessed the advent of the first rifled cannon, but it also furnished for the advocates of armor-plating for ships a powerful argument. The destruction of the Turkish fleet at Sinope, in November, 1853, by the shell-fire of the Russian ships, demonstrated most completely the murderous effect of the new projectile, now for the first time tried in battle, and placed beyond the shadow of a doubt the necessity for armor protection for ships of war. The actual annihilation of 12 out of 13 war-ships and transports within the space of a few hours, with the loss of nearly 4,000 souls, was well calculated to carry conviction.

Up to 1857 the 4½-in. plate had been found to be a fairly equal match for the 68-pounder, but it was easily seen that something offering greater resistance would soon be demanded. The difficulty as well as the cost of producing wrought-iron plates of considerable thickness led to experiments with metal in other forms. In this year, at Woolwich, cast iron was experimented with in the shape of beams 2½ ft. in thickness, tongued and grooved and partially backed with blocks of granite; 68-pounders at 400 yards' range easily cracked and displaced the armor and broke up the granite backing. Later, in Russia, cast-iron blocks 4 ft. in thickness, proposed for forts, were experimented with with a gun of the same caliber firing solid cast-iron shot at short range. The target was destroyed at the fifth shot. In England, in 1859-60, wrought iron in other forms was experimented with in the Thorneycroft shield. This was built up of iron bars, tongued and grooved in horizontal layers, and of various thickness—from 6 in. up to 14 in., with and without backing. It was found to withstand shot up to that of the 120-pounder Armstrong rifle. In 1862 the Inglis target, consisting of two layers of wrought-iron planks crossing each other at right angles, and 12 in. in thickness, was fired at with guns of various calibers, and found capable of resisting perforation from the 300-pounder Armstrong rifle at 700 yards. At West Point, in the same year, the 100-pounder Parrott rifle was able to perforate 6 in. of laminated armor, made up of one inch plates and similar to that used on the Monitors.

Up to the end of 1862 English armor-plate had reached a thickness of from 5½ to 6½ in., and was able to resist the 68-pounder smooth-bore and the 120-pounder rifle, except the latter at the shortest ranges.

In this year a special Committee on Armor, composed of army and navy officers and civilian experts in metallurgy, made an exhaustive report, wherein it was stated that steel and steely-iron were not suitable materials for armor—were much inferior to soft iron. From this date, and for many years, England was committed to wrought-iron armor, and still clings to it in conjunction with steel in her compound armor-plate.

In the development of warlike material there has been quite as much ingenuity displayed, and, one might add, time and money wasted in attempts to perfect armor, as in any other direction. In the United States, the War of the Rebellion was a powerful incentive to the inventive genius of the country. Under the stress of war and urgent necessity all sorts of devices were experimented with by ordnance boards and artillery experts—devices that, seen in the light of present knowledge, seem so absurd that one wonders how they ever came to receive serious consideration.

Among the experiments recorded in 1862-64 in the United States, we have the Hodges wire target, in which, behind a thin laminated plate was placed 14 in. of wire rope in layers, with a backing of wood. An 11-in. gun at short range had no difficulty in riddling the target. An inclined target of laminated plate backed with India rubber and pine met with no better fate. A 4½ in. solid plate, faced with several inches of rubber and another of the same description, both faced and backed with the same material, was also tested. Another target was made up of alternate layers of rubber and wrought iron each an inch in thickness. Perhaps the most absurd experiment recorded was one made at the Washington Navy-Yard, where most of these experiments took place. A 50-pounder rifled gun was pitted against a compressed hog's-hair target about 3 ft. in thickness, with a backing of pine plank. Of the result it is unnecessary to speak.

In England some experiments of the same kind were made: Millboard of considerable thickness as a backing for a thin armor-plate; targets of compressed wool; of iron sandwiched with wood, and others both faced and backed with wood were tried at different times with no satisfactory results; in fact, it may be said that both in England and the United States scarcely one of the targets mentioned survived a single experiment.

With a date corresponding to about the close of the war, the question of armor-plate had passed beyond its purely experimental stage, and the best methods of construction were pretty well established. The solid plate had completely won the day over the laminated one, and the question of proper thickness was the principal one to be decided. Wrought iron held the field, and its claims to superiority over other metals were to be determined at a considerably later day.

As a corollary to the growth of armor-plate was the improvement in the manufacture of projectiles. Whitworth had not only demonstrated the superiority of a spherical steel shot over one of cast iron, but had sent his steel bolt through a target that had defied all other projectiles with an ease that surprised the artillery experts of the day. Still the age of steel, as a military material, had not yet arrived, and the best things the artillerist had to offer against the increasing thickness of the armor-plate were projectiles of chilled cast iron. When, however, soft armor gave place to hard, cast iron in every shape went to the scrap-heap and steel usurped the field.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE report submitted by the Board which conducted the official trials of the new cruiser *Charleston* on the Coast of California, makes a very favorable showing for that vessel. On the four hours' trial run, the average power developed by the engines was 6,666 H. P., the maximum being 6,943 H. P. The average speed during the whole run was 18.187 knots, and the maximum speed was 18.75 knots. The manœuvring power of the vessel was excellent, as she was rapidly managed and turned quickly. The main exception taken by the Board was to the difficulty experienced and time lost in communicating directions to the people stationed in the steering chamber, where the hydraulic apparatus is situated, and the Board say that some more reliable means of communication is desirable; also some device from changing from one steering apparatus to the other nearer the deck. The conclusions reached are that the vessel's hull, fittings and machinery, including the engines, boilers and appurtenances are strong and well built, and, with one or two slight exceptions, in conformance with the contract; the vessel is also in their opinion sufficiently strong to carry the equipment, coal, stores, machinery and the armament which has been

assigned to her. On this report there is no doubt that the *Charleston* will be accepted from the contractors.

Engineer-in-Chief Melville has been during the month in New York making arrangements for building the machinery of the two 3,000-ton cruisers in that yard. The hull of one of these vessels is to be built at the New York yard, and that of the other at the Norfolk Navy Yard, but the machinery for both will be built in the New York yard. Work has already been begun in both yards, laying down the lines for the hulls of these vessels, getting the keel-blocks in place, etc., etc., and the material has been advertised for. The preliminary work is to be hurried as much as possible, and probably the keels will be laid down by the end of the year.

The plans for the two 1,000-ton protected gun-boats authorized by the last naval appropriation bill are nearly completed, and advertisements for bids will shortly be issued. These vessels are known officially as cruisers Nos. 12 and 13, and will be somewhat larger than the *Petrel*, just completed in Baltimore. They will carry batteries of 6-in. rapid-fire guns, and smaller machine guns, will have twin screws with triple-expansion engines capable of working up to about 1,600 H. P. The speed expected is 15 knots per hour. It is believed that these ships will be exceedingly useful to the Navy, and on many stations will answer all the purposes which could be served by a larger and more expensive cruiser. The need of ships of this class has been very much felt. Their cost is limited to $350,000 each.

It is understood that the Commission appointed some months ago to select a site for the purposed navy yard on the South Atlantic or Gulf Coast has not yet reached an agreement, but it is stated that the majority of the Board favor one on the Mississippi River nearly opposite New Orleans. This site is preferred as being on deep water, with facilities for transportation of material and for obtaining skilled labor; but, at the same time, is in a position easily defended in case of war. The navy yard at present owned by the Government at Pensacola is not considered available on account of the unhealthfulness of the situation, its liability to epidemics of yellow fever, and the impossibility of obtaining skilled labor there.

A SQUADRON OF NEW SHIPS.

An opportunity of comparison between some of our new vessels and those of European navies will be afforded shortly. The *Boston*, *Chicago*, *Atlanta* and *Yorktown* are to proceed to European waters as a "squadron of evolution," under the command of Admiral Walker, late Chief of the Bureau of Construction. These vessels are now fitting out and taking in supplies at the New York Navy Yard, and as soon as they are ready will start on an extended cruise, during which there will be full opportunity to test their qualities as cruisers and in every way, in fact, except in actual warfare, for which, fortunately, there is no opportunity offered at present.

TRIALS OF NEW VESSELS.

The gun-boat *Petrel* has been formally accepted by the Navy Department, and has been delivered to the Government at the Norfolk Navy Yard.

Owing to some defects in the indicators used at the first trial of the *Baltimore*, the horse-power developed by her engines was somewhat less than at first supposed, although the high speed made would have hardly indicated this result. The Department, however, has given permission for an additional trial to determine this point.

The test of the guns of the new dynamite cruiser *Vesuvius* was made October 9, the point to be determined being principally the rapidity of fire of the guns with which she is armed. As speed and not accuracy was the important point, blank shells or dummies were used. The first trial made was for distance, shots being fired from each of the three guns which landed respectively 960 ft., 1,050 ft., and 300 ft. beyond the mile limit. Then followed the test for speed. The contract demanded a rate of fire of 15 shots in 30 minutes, and this was successfully passed. The three air reservoirs were charged to 2,000 lbs. at the commencement, and five shots were fired from each gun. The following table shows the result:

Gun.	Time for Firing. M.	S.	Air Loss. Lbs.	Initial Pressure. Lbs.
Port	0	53	70	750
Port	1	45	74	750
Port	2	37	74	750
Port	4	15	76	750
Port	5	11	78	750
Center	6	06	105	750
Center	7	04	109	750
Center	7	55	114	750
Center	9	00	104	750
Center	9	58	96	750
Starboard	11	13	118	750
Starboard	13	03	112	750
Starboard	14	37	105	750
Starboard	15	45	120	750
Starboard	16	50	118	750

Projectile—Full caliber (15 in.), weight averaging 527 lbs.

The *Vesuvius* has now passed successfully the test for speed and for rate of fire, and the guns have also passed the test required for accuracy of aim and for range. She will probably be accepted and put in commission at an early date.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

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(*Continued from page 473.*)

CHAPTER XVII.

A RAILROAD PILE-DRIVER.

What has been said in the previous chapter in regard to piles and pile-driving, simply gives in an elementary form some of the general principles that should be known by any one handling a pile-driving machine. We will now take up pile-drivers as used upon the railroads in this country. The use of the pile-driver upon a railroad is not only for driving piles for foundations, retaining walls, and such ordinary purposes where they are to become permanent fixtures; but the great utility of piles upon railroads is the facility with which they can be used for repairing any washouts or breaks in the track, due to any cause. Consequently, the following are the requisites in a railroad pile-driver:

1. The pile-driver must be mounted upon a car, so as to be moved from place to place upon the track.

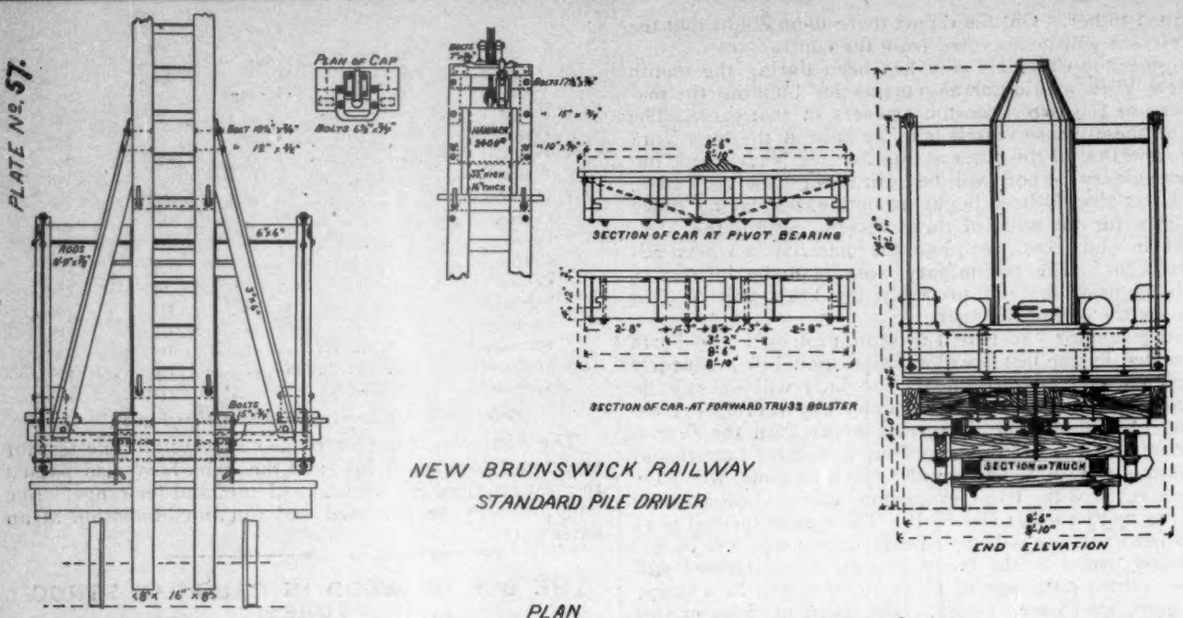
2. The leads must be so arranged as to fold back in order to allow of the passage of the pile-driver through the bridges upon the road.

3. Owing to the rapidity with which the work must be done in case of accident, or in the case of driving piles upon a road over which trains are running, the pile-driver should be so constructed that very little time need be lost in putting it in working order, and getting to work, and also in folding it up and making it ready for transportation. Many of the otherwise most excellent pile-drivers, or track-drivers, in this country, are rendered almost useless from the fact that their complication is so great that too much time is lost in putting them in working order, and then preparing them again for transportation.

4. As the principal use of the pile-driver is in driving piles across a washout or opening of some kind in the track, where it is impossible for the pile-driver to stand directly over the pile it is driving, some arrangement is necessary by which piles can be driven ahead of the point of support upon which the pile-driving car rests.

5. The pile-driver must be so constructed that it can drive not only a certain distance straight ahead, but also that it can be turned so as to drive a certain distance on each side of the track. In other words, it must be made to swing on a pivot for a certain distance each side of the center line, and also be able to drive ahead of itself a certain required distance.

PLATE No. 57.



NEW BRUNSWICK RAILWAY
STANDARD PILE DRIVER

PLAN

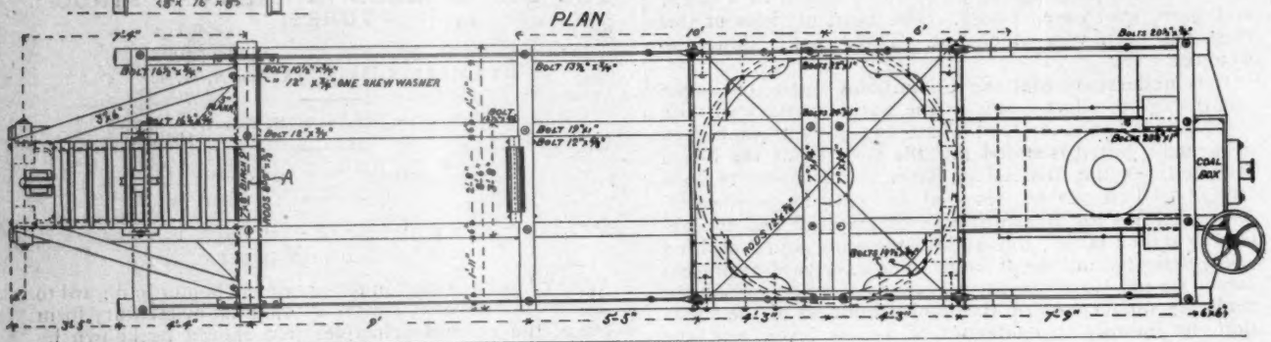
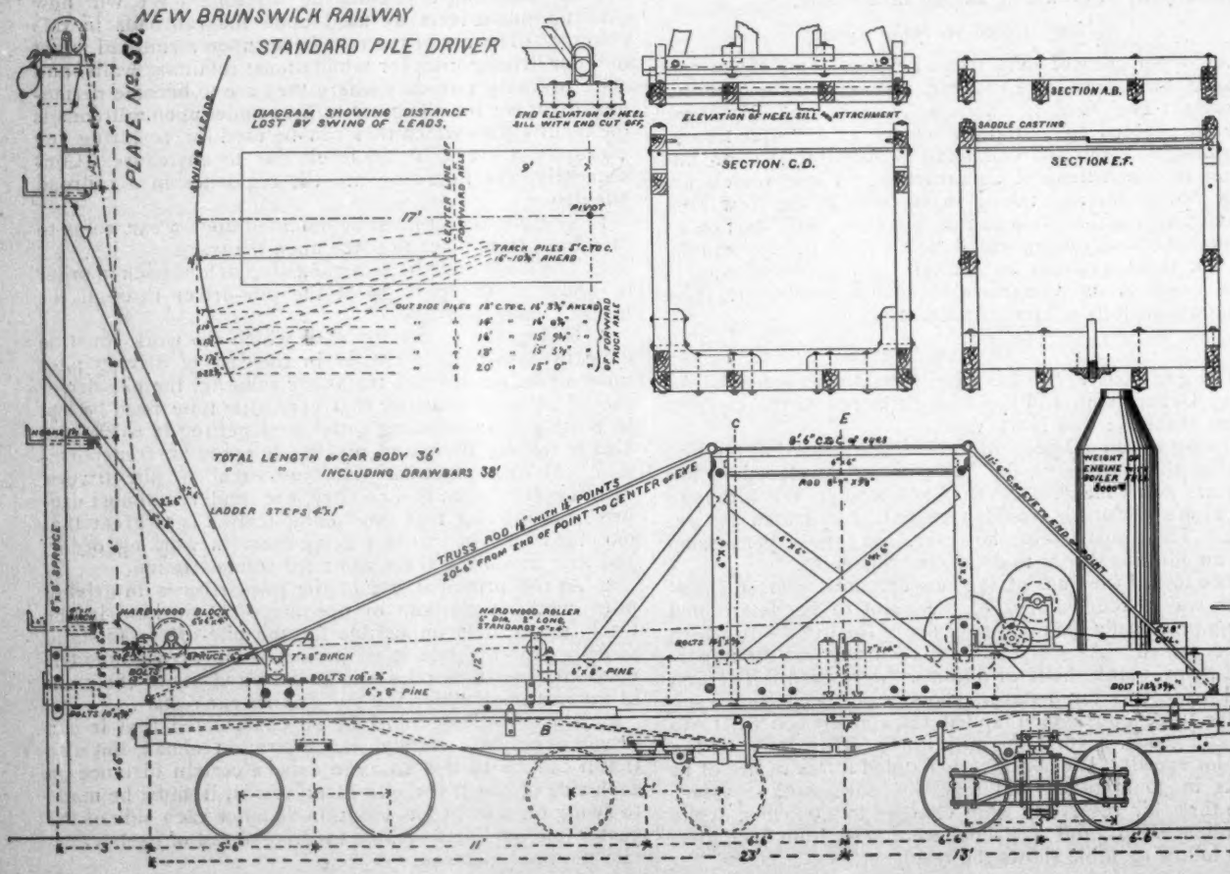
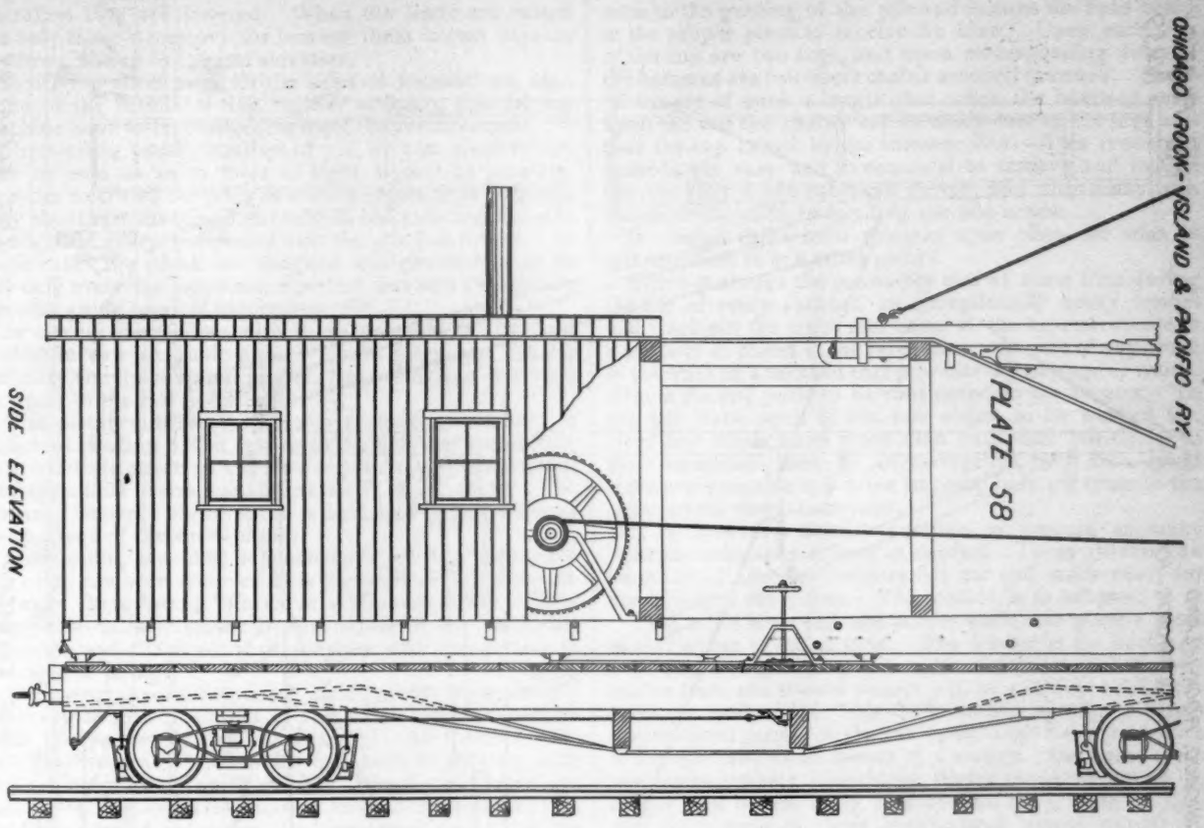


PLATE No. 56.

NEW BRUNSWICK RAILWAY
STANDARD PILE DRIVER





Plates 56 and 57 show full plans, with details, of the standard pile-driver of the New Brunswick Railroad. All railroad pile-drivers are to a certain extent of this general form. A few of the details in connection with this pile-driver appear to the Author to be of great excellency; therefore this one has been selected among others to illustrate the subject. As will be seen by an examination of the plate, the leads in this pile-driver are 22 ft. 6 in. long. The two braces that hold these leads in a vertical position are firmly bolted to the leads, and owing to the construction of the pile-driver, there is no necessity for unbolting them. The leads, together with the braces, turn upon a pivot point marked *A*. During transportation these leads are shut back upon the top of the gallows-frame shown in the drawing, and the forward trucks of the car are in the position shown by the full lines in the side elevation. When it is desired to put the driver in shape for work, the leads are drawn to a vertical position by means of the stationary engine, and the only thing necessary is to key them firmly in position to the bottom sill of the driver. These keys can be readily seen in the front elevation of the leads. The leads are raised and lowered entirely by means of the stationary engine, the hammer being placed at a certain point which is marked in the leads where it balances. Very little power is required to move them, and there is no danger of any accident. When the driver is in shape for work, the forward trucks are run back from their original position to a position shown by the dotted lines in the side elevation, thus allowing the driving of piles about 15 ft. ahead of the points of support.

The diagram on Plate 56 shows exactly the swing of the driver, and the distances lost by swinging each way from the center.

The following is the complete bill of material necessary for the construction of this driver. The great advantages connected with it are the extreme simplicity of its construction, the great strength attained at very little cost, and the quickness and ease with which it can be put in working order at any required place, together with the small amount of time lost in making it ready for transportation. Thus, if work is to be done in any place where the time is very limited, such as working between trains that are running with only a limited amount of time between, the amount of actual time lost in erecting and taking down this pile-driver is very small. This pile-driver was designed in all its details by Moses Burpee, Chief Engineer of the New Brunswick Railway, and for efficiency in work has given the greatest satisfaction.

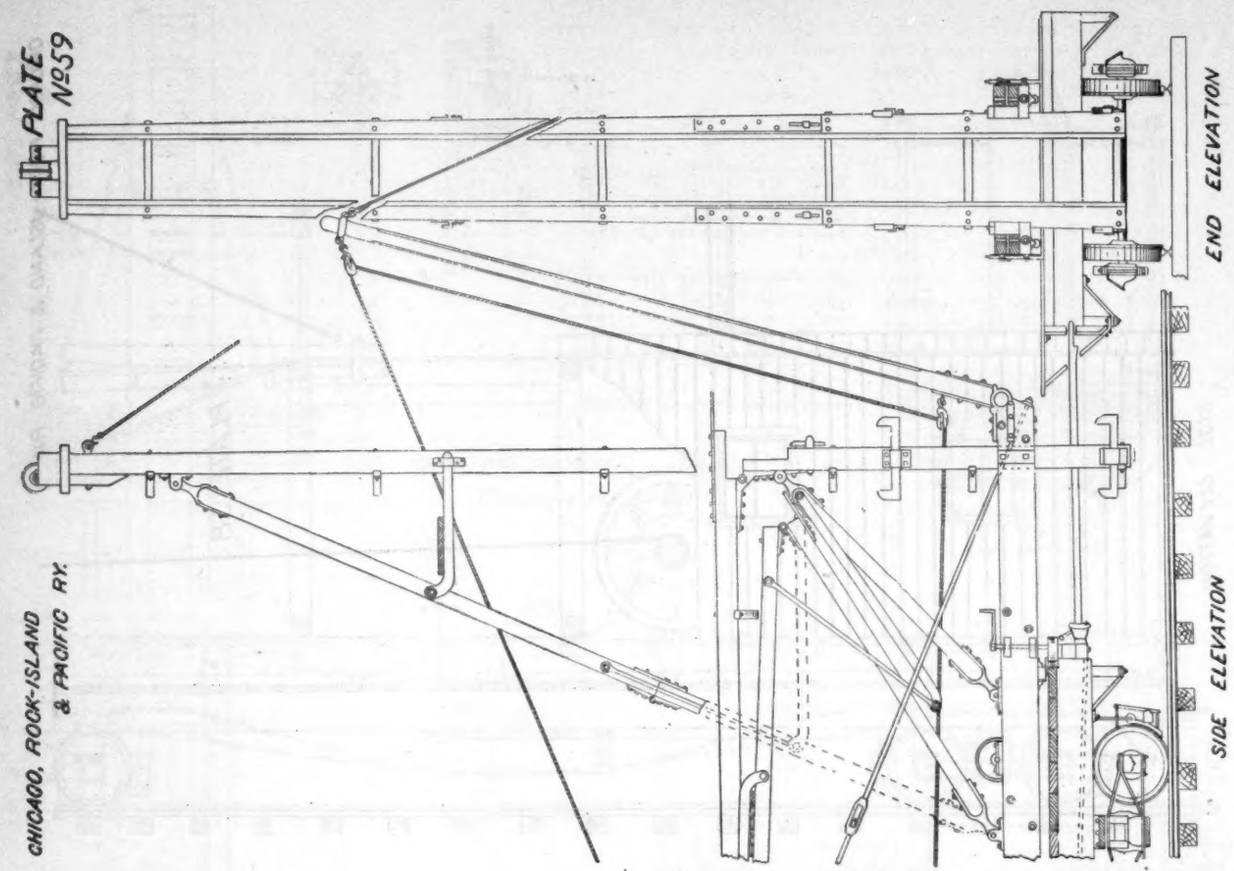
No. 33. Bill of Material for New Brunswick Railway Standard Pile-Driver. Plates 56 and 57.

Wood, Top Frame:

NO.	DESCRIPTION.	SIZE.	LENGTH.	TIMBER.
2.	Sills.	6 in. × 8 in.	39 ft. 5 in.	H. Pine.
2.	"	" "	35 ft. 6 in.	"
2.	Bolsters.	" "	16 ft.	"
4.	Posts.	6 in. × 6 in.	7 ft.	"
4.	Braces.	" "	9 ft. 2 in.	"
2.	"	" "	7 ft. 2 in.	"
4.	Struts.	" "	7 ft. 10 in.	"
2.	Center Pin Bolsters.	7 in. × 14 in.	8 ft. 6 in.	"
3.	Cross Sills.	6 in. × 8 in.	8 ft. 6 in.	"
2.	Planks.	2 in. × 8 in.	8 ft. 6 in.	"
4.	Sill Struts.	6 in. × 8 in.	2 ft. 3 in.	"
2	" "	" "	3 ft.	"
8.	Knees.	6 in. × 6 in.	3 ft. × 2 ft.	Hack.

Wood, Leads, etc.:

2.	Leads.	8 in. × 8 in.	24 ft. 9 in.	Spruce.
2.	Ladder Rails.	3 in. × 6 in.	16 ft.	"
2.	Lead Braces.	" "	13 ft.	"
9.	Ladder Steps.	4 in. × 1 in.	2 ft. 10 in.	"
1.	" "	4 in. × 4. in.	2 ft. 10 in.	"
2.	Lead Sills.	6 in. × 8 in.	8 ft.	"
2.	Blocks.	6 in. × 8 in.	8 in.	"
1.	Plank.	2 in. × 6 in.	8 ft. 6 in.	"
3.	Yokes.	4 in. × 11 in.	2 ft. 8 in.	Birch.
1.	Cap.	4 in. × 16 in.	2 ft. 8 in.	"
2.	Brackets.	3 in. × 7 in.	1 ft. 6 in.	"
1.	Heel Sill.	7 in. × 8 in.	9 ft.	"



Iron :

NO.	DESCRIPTION.	LENGTH.	SIZE.	REMARKS.
2.	Rods.	20 ft. 6 in.	1⅛ in.	1¼ in. screw ends. Double eye on the other end.
2.	"	21 ft. 6 in.	1⅛ in.	
2.	"	8 ft. 6 in.	1⅛ in.	Single eye each end.
4.	Pins.	4 in.	1¼ in.	Head and Nut.
2.	Rods.	12 ft.	⅞ in.	" "
8.	"	8 ft. 9 in.	⅞ in.	" "
4.	Bolts.	24 in.	1 in.	" "
4.	"	22 in.	1 in.	" "
2.	"	20½ in.	1 in.	" "
2.	"	19 in.	1 in.	" "
2.	"	16½ in.	1 in.	" "
2.	"	20½ in.	⅞ in.	" "
10.	"	18½ in.	⅞ in.	" "
12.	"	16½ in.	⅞ in.	" "
24.	"	14¾ in.	¾ in.	" "
2.	"	12½ in.	¾ in.	" "
9.	"	12 in.	¾ in.	" "
10.	"	10½ in.	¾ in.	" "
4.	"	10 in.	¾ in.	" "
2.	"	8½ in.	¾ in.	" "
8.	Lag Screws.	9 in.	¾ in.	" "
24.	" "	8 in.	¾ in.	" "
2.	Bolts.	17½ in.	¾ in.	" "
8.	"	15 in.	¾ in.	" "
4.	"	12 in.	¾ in.	" "
2.	"	10½ in.	¾ in.	" "
4.	"	10 in.	¾ in.	" "
2.	"	7 in.	¾ in.	" "
2.	"	6½ in.	¾ in.	" "
184.	Cast Washers.		¾ in.	
28.	"		1 in.	

In this Standard Pile-Driver of the New Brunswick Railway, which is shown above, a very important and ingenious mechanical detail is the sheave for the hammer line at the bottom of the leads, and the two smaller sheaves or rollers, with flanges, which embrace the outside of the main sheave, and are moved on that account with the main sheave by the change of the furniture of the line on the drum, both main sheave and the smaller ones being loose upon parallel shafts. The object of this is to allow the rope to run always in a true line and thus prevent wear upon the sides of the sheave, which is free to move laterally upon its shaft.

The engine used on this driver is a double-drum double engine made by Kendall & Roberts, Cambridgeport, Mass., fitted with friction clutches and also foot-brakes. This engine has given entire satisfaction during the time it has been in use.

The driver complete cost $2,000, including $275 duty on the engine. The rapidity with which it can be put in working shape or lowered for transportation, and the generally satisfactory manner in which it does its work have proved the advantages attending its details of design and construction.

Plates Nos. 58 and 59 give the plans of the Pile-Driver used upon the Iowa Division of the Chicago, Rock Island & Pacific Railway.

In designing this driver—as in the one previously described—the objects aimed at have been :

1. Rigidity and stability while at work.
2. Ease and rapidity of changing from a position suitable for work to one suitable for transportation.
3. Simplicity and fewness of parts.

The main brace, which holds the leads in an upright position, is fastened at both ends with a pin-joint and has a hinge-joint in the center, as shown in plate 59, side elevation. The leads have a hinge-joint at the height of the gallows-frame, and the leads when in shape for transportation are folded back upon the gallows-frame, as shown in the side elevation. The main brace remains fastened at each end, but doubles at its center and folds under the leads as shown.

The boom projecting in front of the car is for the purpose of raising and lowering the leads. This boom is connected with the car-body by means of a joint, which allows of free movement in a vertical plane. At each end of the boom is fastened a snatch-block. The raising line runs from the winding drum through the lower snatch-block, from there up the boom through the upper snatch-block and thus to the head of the leads. From the upper end of the boom a guy-line is run forward and made fast to the track. Then by taking in the rope on the drum, the leads are brought into an upright position, and by the reverse

operation they are lowered. When the leads are raised the only thing necessary for locking them is two keys on the front, shown in the end elevation.

In driving sheet-piles for the sides of foundations, etc., some of the details of the regular ordinary pile-driving machine have to be changed to meet the requirements.

Sheet-piling usually consists of 2 in. or 3 in. plank driven side by side so as to form as tight a joint as possible. In order to crowd the piles as closely together as possible, they should be sharpened entirely on one side and the side or edge not sharpened placed next the pile last driven. In some cases the plank are tongued and grooved so as to not only make the joints more perfect, but also to partially act as a guide to each succeeding pile.

In driving sheet-piling, also, it is customary to drive first a double row of guide-piles. These piles are usually ordinary square or round timber, and are driven 6 ft. or 8 ft. apart in the line of the wall.

The distance between the two rows of guide-piles is sufficient to allow of the bolting to the inside of the outside row and the outside of the inside row, parallel horizontal timbers called wales, usually about 6 in. × 10 in. The distance between these wales is sufficient to just allow of the passage of the sheet-piling.

Sheet-piling should be supported every 6 ft. or 8 ft. when the earth has been removed from the inside. The distance between these lateral braces or additional wales will in every case be determined by the nature of the supported material, and the amount of pressure that is necessary to sustain the piling.

In driving sheet-piling some arrangement must usually be made so that the leads of the driver do not interfere with the previously driven piles, and also that the piles may be driven nearer to walls, etc., than is possible with the ordinary driver as described. These two points are usually secured by giving such a form to the hammer that only one lead is necessary, the hammer sliding upon the front of that lead.

In driving false works for bridges, etc., it is very often necessary to drive some distance below the level upon which the driver stands. This is accomplished in two ways:

1. By using a "dolly," or follower, spliced to the top of the pile as has been described.

2. By using a specially constructed lead and hammer so arranged that the lead can be lowered below the track level and the hammer slide upon it.

Upon the Iowa Division of the Chicago, Rock Island & Pacific Railway the following arrangement has been in use some years and has given satisfaction: The lead is in the form of an iron rod which passes through the hammer and rests on the top of the pile. This rod descends with the pile sliding through guides attached to the body of the driver.

There is a simple mechanical device on the guides that prevents the rod from being raised from the pile with the hammer.

In addition to what has been said in regard to banding the heads of piles to prevent their splitting and breaking, we wish to call attention to the following: The disadvantages connected with the use of bands are:

1. The time lost in placing them in position.

2. The slight effect they have in preserving the piles under some circumstances.

3. The time lost and difficulty attending their removal. This last is by far the most serious objection. In order to accomplish the object aimed at in the use of the bands, viz., the preservation of the piles while being driven, there has of late years been used an iron cap. This iron cap is made concave on both the top and bottom. The bottom is made to fit over the head of the pile, which is beveled off to the proper amount to receive it. In the cavity upon the top of the cap is placed a piece of hard wood which serves as a cushion to receive the hammer blow. The face of the hammer is made of suitable form to match the cap. By this arrangement the head of the pile is well preserved during the process of driving.

The cap is constructed by grooves in the sides the same as the hammer, so that it may be held firmly in place and slide in the leads. By this means it offers great assistance to the guiding of the pile and insures the head being in the proper place to receive the blow. Upon each side of the cap are two lugs, and upon corresponding sides of the hammer are two short chains securely fastened. These chains are of such a length that when the hammer rests upon the cap the chains can be made fast to the lugs and thus the cap raised by the hammer line. This renders it exceedingly easy and economical to remove and handle the cap after a pile has been driven, and does away with the third objection to banding the pile heads.

In closing these brief remarks upon piles, we wish to call attention to one other point:

There is always the possibility that at some time during the life of every railroad an exceptionally heavy freshet will wash out the track and some of the superstructure in a number of places at the same time. In case of any break in the track of a railroad that prevents the passage of trains, *time* is the one point to be considered in the repairs. To get the track open is the one object to be worked for. Very few roads have more than one track pile-driver at their command, even in an emergency, and even when more are available it is often impossible to get them to the point where they are needed.

It is, however, usually possible to procure as many ordinary stationary drivers as needed. These drivers can be mounted upon an ordinary flat car and made ready for use in a very short time. The method is as follows:

Take a platform car and across each end place a piece of timber say 12 in. × 12 in. The timber at the back end need be no longer than the width of the car, but the one on the front end should project 3 ft. or 4 ft. beyond the car body on each side. This front timber is to be securely lashed to the frame of the car body, and the lashings are to be tightened up by means of a wedge. On top of these two cross-timbers place four sticks about 16 or 17 ft. longer than the car body, and about 8 in. × 10 in. in size. The back ends of these longitudinal pieces should be together near the center line of the car and the other ends should project in front. These front ends are to be spread apart sufficiently to include within their outside limits a distance each side from the center of the track greater than the side distances of the outside piles to be driven. These longitudinal timbers must be firmly lashed to the car body and secured by wedges. These wedges are driven between the timbers and the lashings. This frame is then floored over with a sufficient number of plank to enable the men to pass back and forth, and also to hold the frame of the pile-driver. This frame is then set upon the flooring, and secured in any manner that will insure its upright position and allow of its being thrown to the right or left as may be necessary. If the stationary engine is not on the lead frame it can be put upon the rear of the car, and it, together with the necessary fuel, will serve as a counterbalance to the leads and hammer.

It is often a good plan to run out guy-ropes each side from the top of the leads in order to render them secure when a cross pull is brought upon them in lifting the piles into place.

In case no small, suitable stationary engine is available, the hammer can be raised by attaching the line to the draw-bar of a locomotive. This method is slow and in itself very expensive. The matter of expense, however, is one of minor importance provided the work can be pushed.

A CORRECTION.

In Chapter XVI, in the October number of the JOURNAL, page 473, the equation written:

$$W \times H \frac{P^2 \times L}{4 P S}$$

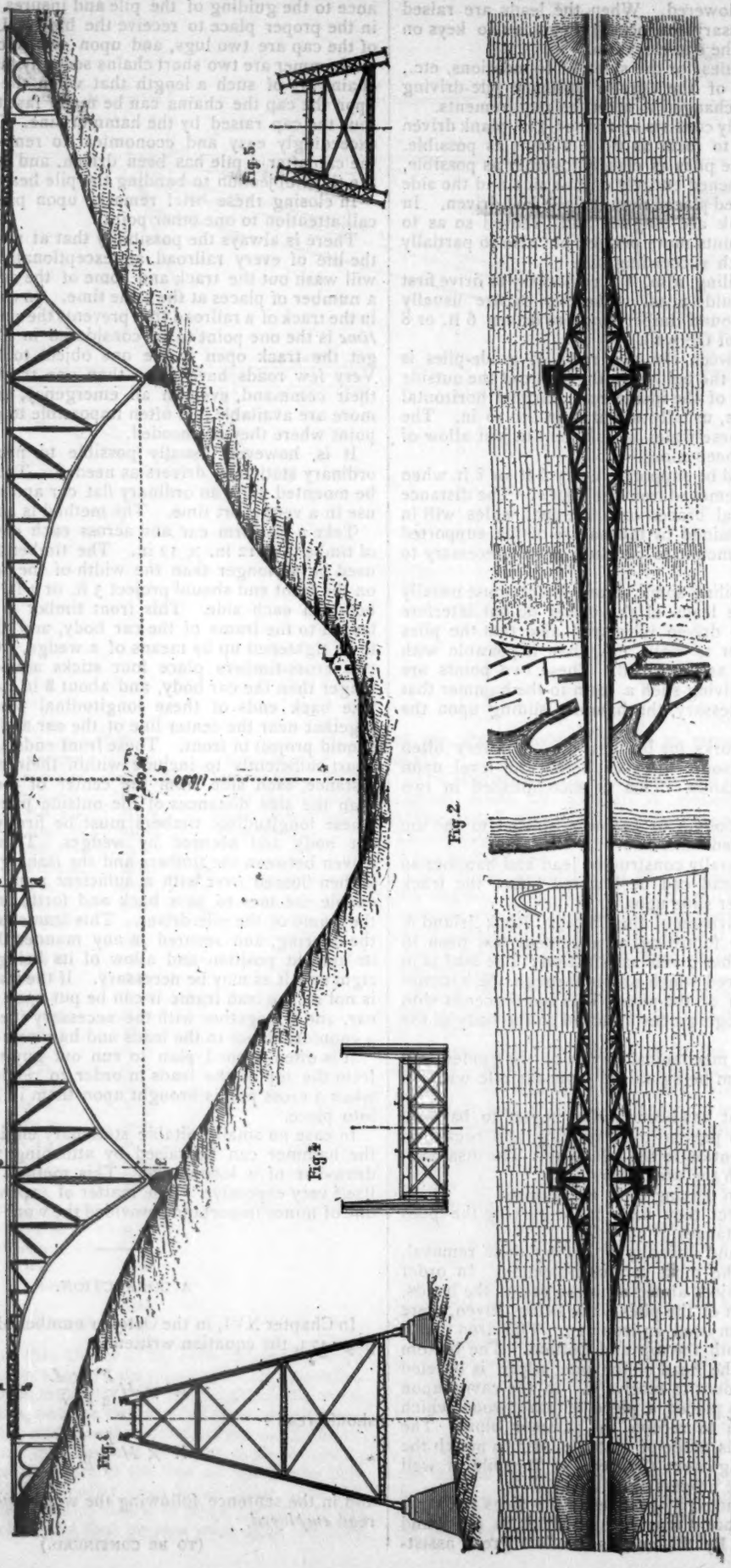
should read:

$$W \times H \frac{P^2 \times L}{4 E S},$$

and in the sentence following the word *multiplied* should read *employed*.

AUTHOR.

(TO BE CONTINUED.)



THE VIAUR VIADUCT.

DESIGNED BY THE SOCIÉTÉ DE CONSTRUCTION DE BATIGNOLLES.

THE VIAUR VIADUCT.

(From *Le Genie Civil.*)

THE plan for the Viaur Viaduct, a model of which is seen in the Paris Exposition, has been made for the crossing of the valley of the Viaur on the new line from Carmaux to Rodez, and is the result of a competition arranged by the Government for the design and construction of this work.

The Commission of engineers appointed to examine the plans submitted by different constructors has chosen that submitted by the Société de Construction des Batignolles, and this selection has been approved by the Minister of Public Works, who has ordered the construction of this important bridge by the company named. The engraving shows the general plan and arrangement of the work. In these illustrations, fig. 1 is the general elevation; fig. 2 a plan; fig. 3 a section on the line *e f*; fig. 4 a section on the line *a b*; and fig. 5 a section at *c d*.

The bridge consists of a metallic arch composed of two symmetrical halves joined at the center. Each of the halves has the form of a triangle, with two curvilinear sides, and with the apex, which is opposite the rectilinear side, placed below, giving the general appearance of an arch prolonged on each side to the abutments by a second and smaller triangle. The sides of the triangle formed by each half of the central arch are chords united by rigid braces composed of vertical or oblique columns.

The metallic structure rests upon masonry piers through the medium of flexible joints, and at the extremities nearest the ends of the bridge supports a short metal truss, the other end of which rests upon the masonry abutment which forms the end of the bridge. This arrangement has been adopted in order to allow for any slight motion in the ends of the central truss.

The two main trusses are inclined to the vertical in such a way as to present the resistance necessary for the stability of the structure. At their upper end they support cross girders upon which the track rests. Cross-bracing placed in the vertical plane, or in the plane of the lower chord, completes the structure. This arrangement presents the following advantages:

1. The presence of the three flexible joints permits an exact determination of the thrust, and the strains to which the different parts of the structure are submitted can be exactly determined, since there are no superfluous parts.

2. No strains will be developed either during construction or in service, except those which result from the weight of the bridge itself, the moving load, and the wind.

3. The flexible joint in the center permits the adjustment of the arch without trouble and without submitting any part to abnormal strains, which are very difficult to determine, and which are always caused in the erection of a continuous arch.

4. The whole arrangement diminishes the thrusts, enables the constructor to divide the strain better between the chords, and facilitates the erection. During the erection, the central portion is held in equilibrium, partly by the weight of the outer ends of the triangles, and partly by braces or cables properly secured, the action of which will not at all modify the strains when the construction is completed.

5. The joints give full freedom for expansion and contraction of the structure due to the changes of temperature.

The possible variations under the action of vertical loads, of the wind, or of expansion and contraction, have been worked out with very great care. They are very slight, and are, indeed, less than those of the largest structures of this nature now in existence. The proportions are so arranged that the arch cannot open at the center under the action of the most violent winds, and, moreover, to prevent any danger on this point, the central joint or key will be furnished with additional links or connections which will hold the two sections of the arch at this point, without interfering at all with the free movement of the joint.

The principal dimensions of this work are as follows:

Total length of viaduct	460.00 meters	(1,508.80 ft.)
Length of metallic structure	410.00 "	(1,344.80 ")
Span of central arch	250.00 meters	(820.00 ft.)
Distance from end of central arch to abutment on each side	80.00 "	(262.40 ")
Rise of the arch	45.40 "	(148.91 ")
Height from bottom of the valley to rail	116.80 "	(383.10 ")

The opening of 250 meters (820 ft.) of the central arch will give this bridge the longest span of any work existing in France. The Garabit Viaduct is higher, the rail being 122 meters (400 ft.) above the bottom of the valley, but the great arch in that viaduct is only 165 meters (541 ft.) span. The span, however, of the Viaur Viaduct is exceeded in the great Forth Bridge now under construction in Scotland.

FRENCH CRITICISM OF OUR WAR-SHIPS.

ADMIRAL DE COULSTROM, accompanied by the field officers of the *Aréthuse*, recently visited Cramp's ship-yard in Philadelphia. The Admiral is reported to have made the following criticisms of the *Vesuvius* and *Baltimore*:

"The pneumatic guns are wonderful inventions," he said, "but their value is undetermined. Their destructiveness is unquestionable if the boat can reach within throwing distance of the boat to be attacked. Here is where the trouble comes in. An iron-clad can completely destroy it, with its long-range gun, before it is able to get in range with it. With this point the objectionable feature stops, for, from practical demonstration, it has been shown that the dynamite shell can blow the largest vessel afloat into a thousand atoms, if it falls within 20 ft. of it in the water."

The Admiral criticised the unprotected upper gun decks of the *Baltimore*. "Men will not stand to the guns," he said, "without more substantial protection in front of them. I have tried it." He praised the efficiency of the machinery, but severely criticised the accommodations of the Admiral's quarters. "Why, they are like a prison," he said. "They are unnecessarily small. Here is a shaft which could be easily placed 20 ft. further forward and give double the room. The room is on the gun deck. It ought to be where the Captain's is—where he can see the working of the ship. As it is now, he is off the earth. Here you have it so arranged that the Admiral eats by himself, and so does the Captain. I eat with my field officers."

The Admiral praised the other appointments of the new cruiser. He said that the French Government has just had built a steel cruiser, named the *Forbin*, which is equally as fast and well arranged as the *Baltimore*. It has attained the speed of 20.6 knots per hour, "and," he said, "with the utilization possible of extra power, we hope to greatly increase this record."

IS GASEOUS FUEL ECONOMICAL?

AT a recent meeting of the Iron & Steel Institute, held in Paris, Sir Lowthian Bell read a paper on Gaseous Fuel, which excited an animated discussion. His conclusions were that for every 100 units of fuel burned there is utilized by coal 83.93 per cent. of its heat; by producer-gas 71.14 per cent., and by water-gas and its producer-gas 78.80 per cent.

In reply to this, it was said that there was no general rule as to solid fuel being more economical than gaseous fuel; in some cases it was better to have the one and sometimes the other. It was also known that a certain amount of the heat energy of the fuel must be expended in the process of the conversion of the gas. The case of a large mill in Italy was cited in which there were 22 boilers heated by gas made in producers, in which it was found there was no economy.

On the other hand, it was said that while a certain amount of the heat energy of the fuel must be expended in the process of conversion into gas, it must be remembered that it was not possible to burn solid fuel without introducing something like twice the quantity of air theoretically required for its combustion from the fuel and insure its being supplied with a sufficiency of oxygen. Moreover, this supply of air had to be drawn in by a strong chimney draft, which causes a rapid withdrawal of the

heated currents, and so a further loss was sustained. With gas it was not necessary to have so large an excess of air present, and very little chimney draft sufficed, and consequently there was a comparative gain. Further than this, the gas could, when required, be heated before combustion by means of the outgoing products, but with solid fuel this was impossible.

Another speaker said that the object in using gaseous fuel was to convert it into a more manageable form, and its employment might be advantageous when the heat was needed under exact regulation, and with a minimum of labor and dirt. A temperature was obtainable with the gaseous fuel which was absolutely unattainable with solid fuel, and that proved that when high temperature was required gaseous fuel was the only form in which to use fuel, and when heat was required to be under control, gas offered the readiest means of regulation.

The discussion, of course, had no reference to the use of natural gas, which does not exist in quantities which make its use practicable in England.

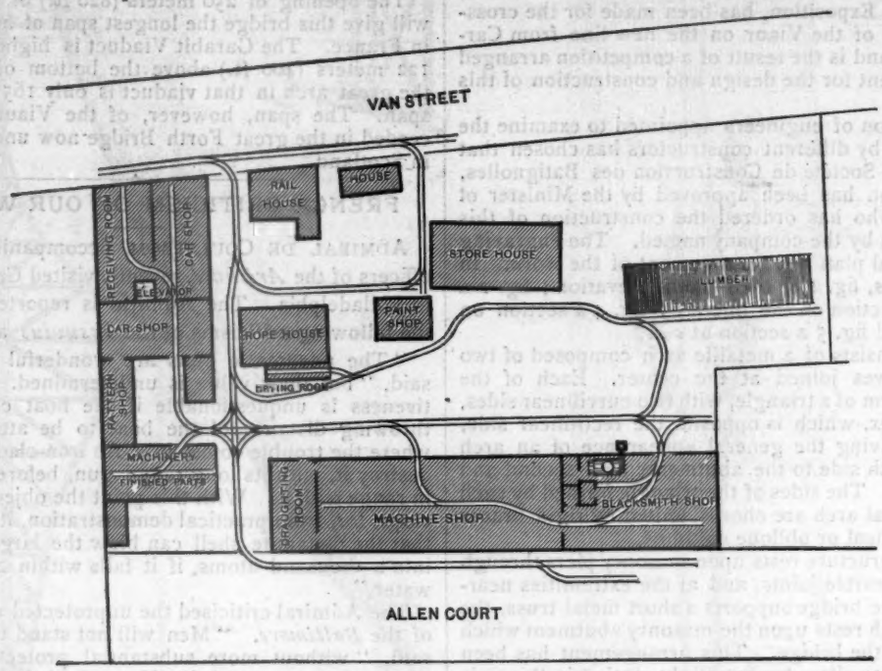


Fig. 1.

The C. W. Hunt Company's Narrow-Gauge Railroads.

PROBABLY there are many of the generation of young railroad men who are so rapidly filling the places of those who have crossed the summit of the divide which separates the first half century of our lives from that greater or lesser fraction of 50 years which remains to us on the descending portion of the journey of life, who took no part or interest, or do not even remember the controversy over the advantages and disadvantages of narrow as compared with standard-gauge railroads, which was started by a paper on "The Railways of the Future," that was read by Mr. Robert Fairlie before the British Association in 1870. There seemed to be contagion in the fallacies which were presented to that learned body, so that they spread like a disease. With one exception, the railroad and engineering papers everywhere became advocates of the narrow-gauge system, and many roads were built and much money was wasted as a consequence of the delusions, which so many at that time seemed to take pleasure and comfort in believing. It is not intended here to review the discussion of this subject any further than to quote from a pamphlet, before us, describing the C. W. Hunt Company's system of narrow-gauge railroads,* in which it is said that "it was designed for the special work of handling material in and around manufacturing establishments, and it is not intended to carry passengers, or to be in any way a competitor with the standard-gauge system." In the pamphlet the discussion of years ago is summed up very concisely in a sentence, in which it is said that "the fallacy in the common arguments for narrow-gauge railroads was, that the width between the rails was taken as the base of the system, whereas that is little more than an incident, and the dimensions of the railroad must be governed by the speed of the trains and the size and weight of the loads which the traffic requires." This recalls a discussion which occurred between a narrow-gauge enthusiast and a skeptic years ago, in which the believer asserted that nature in forming the deep cañons in the West had made them of a width which was just wide enough to admit a narrow-gauge car, but would not admit one of greater width. The disbeliever expressed incredulity, and retorted that if you wanted to build a railroad to run into a rat-hole, that obviously a narrow gauge was essential. Now, metaphorically speaking, the C. W. Hunt Company have devised a system of railroads to run into rat-holes, or, in other words, for service in and about manufacturing establishments of various kinds—mines, plantations, navy-yards, military reservations, etc. A plan of their own works at West New Brighton, Staten Island, N. Y., fig. 1, furnishes a good example of the use of such a road. The reasons given for the adoption of a narrow gauge for such lines

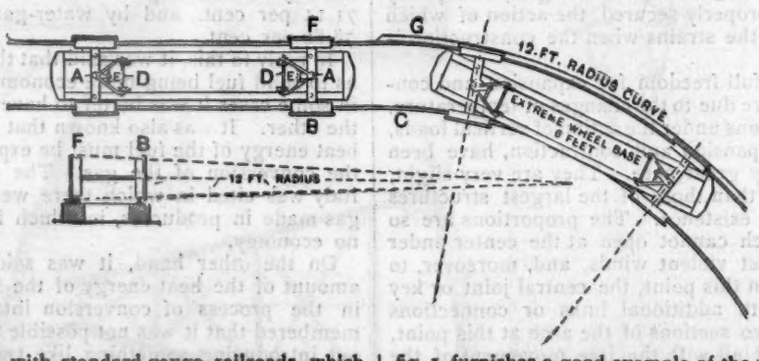


Fig. 2.

* Liberal quotations have been made from this pamphlet in preparing this article.

are the following: The curves can be of short radius; turntables can be dispensed with; the tracks can be easily run in doorways and confined places; obstructions can be readily avoided; cars can be run anywhere that a team can be driven; locomotives can be used with great advantage; any load that the business requires can be carried, and the expense of operation is small. These reasons all seem to be sound, and only need to be stated to be accepted.

As mentioned before, for much of the service for which the Hunt system of roads has been designed, curves of short radius

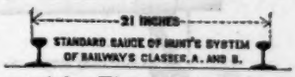


Fig. 3.

are absolutely essential. The system was, therefore, arranged for a minimum radius of 12 ft., measured from the center of the circle to the center of the rails. As many of the cars used are intended to be moved by hand, it was desirable to reduce the resistance on curves to the smallest possible amount, and for several years a study was made of this subject. Almost every device for reducing the friction of the wheels on the curves was examined, and quite a number of them were tried. It is said further that "wheels running loosely upon the axles are so thoroughly bad mechanically, that they have been rigorously excluded, and only wheels rigidly fastened to the axles are used." In this short sentence the illusion concerning the use of loose wheels, which has the demerit of being immortal, is finally dismissed.

Fig. 4. Stone Car.

Fig. 5. Self-dumping Car.

Fig. 6. Side-dumping Coal Car.

Fig. 7. Pig-iron Car.

Fig. 8. Charging Car for Furnaces.

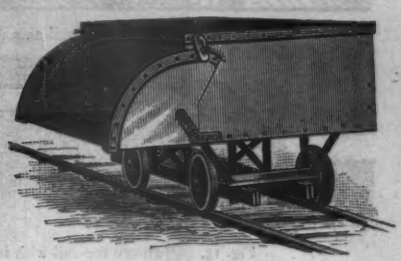


Fig. 9. Car for Hot Coke.

The resistance of cars, which is ordinarily due to the curvature of the track, they say, arises, first, from the difference in the length of the inner and the outer rails, so that if the wheels are of equal diameters, either those on the inside or those on the outside of the curve must slip circumferentially; second, from the divergence of the curve from a straight line, compelling the wheels to slide laterally; and third, from the friction of the wheel flanges against the rails. It is well known that a frustum of a cone will roll in a curved path as freely as a cylinder will roll in a straight line; but to do so the axis of the frustum must conform to the positions of radii of the curve. If, then, a pair of wheels were made of unequal diameters, so that their rolling action would practically be the same as that of a frustum of a cone, and if the axle could adjust itself radially to the curves, then the wheels would roll on a curve as easily as on a straight line. To meet these conditions, the Hunt Company arranges the rails of curves so that the wheels on the outside will run on their flanges, and in order that the axles may assume radial positions to the curves, the plan of construction represented by fig. 2 has been adopted. In this a pair of wheels, rigidly fast-

Fig. 10.

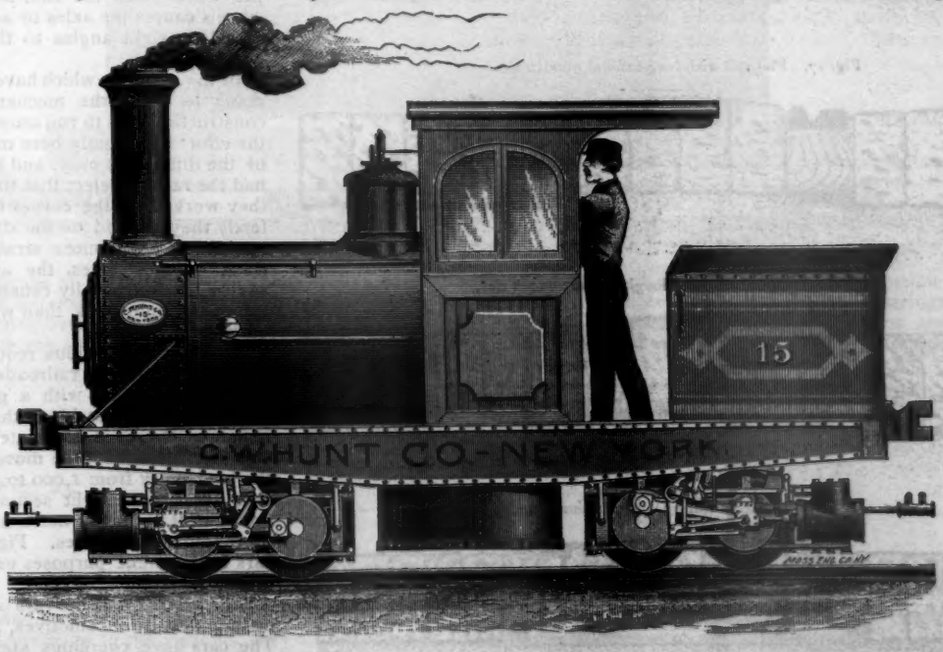


Fig. 11. Ordinary tee-rail on a plank floor.

Fig. 12. Guard rails, used to make the rail heads even with the surface of the floor.

Fig. 13. Flat rail on a floor with the space filled in.

Fig. 14. Grooved rail on a floor with the space filled in.

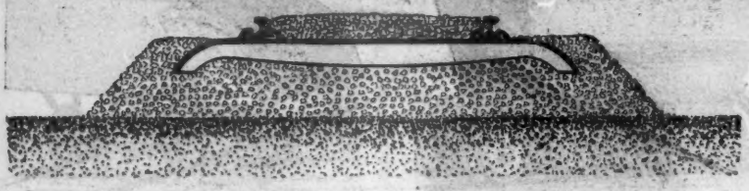


Fig. 15. Ordinary tee-rail with iron ties for a permanent railway.

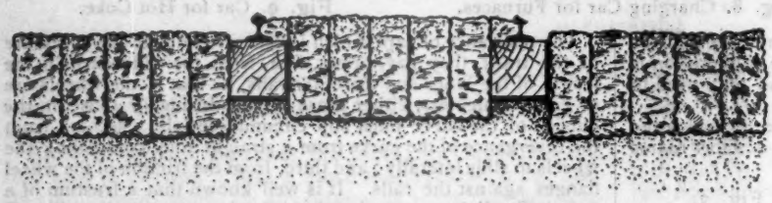


Fig. 16. Ordinary tee-rail with longitudinal wooden ties.

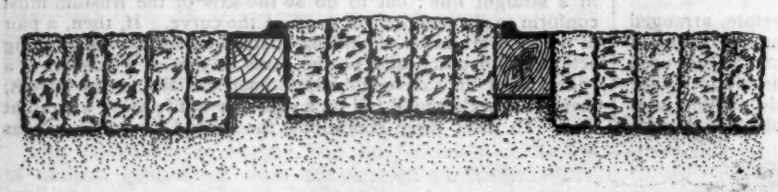


Fig. 17. Flat rail with longitudinal wooden ties.

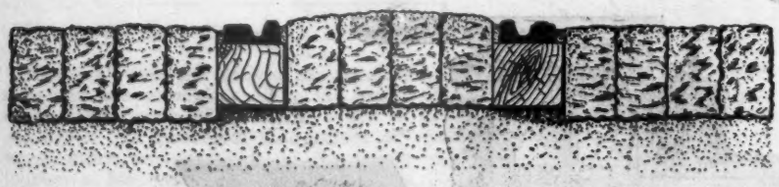


Fig. 18. Grooved rail with longitudinal wooden ties.

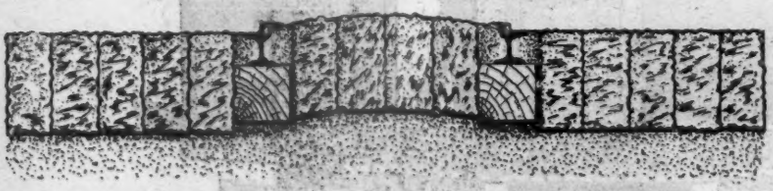


Fig. 19. Johnson patent rail with longitudinal wooden ties.

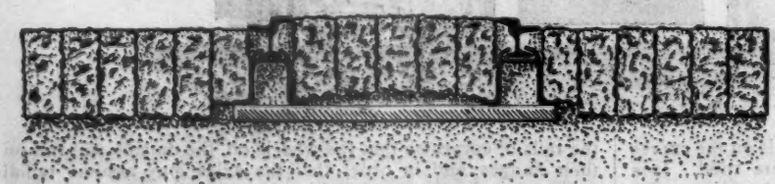


Fig. 20. Johnson patent rail with iron ties.

ened to the axles, is placed at each end of the car. These run in bearings that are connected together and have a central pivot, *A*. The car is hung on the bearings by links, so that on curves the axles are free to turn in a radial direction around the pivots *A A*, as shown on the right side of fig. 2, somewhat as the front axle of a wagon does about its kingbolt. The axles are attached by the pivots *A A* to the triangular-shaped frames *E E*, which are hinged to the car at *D D*, so that the pivot *A* can move vertically, but not horizontally. With this arrangement, if the flanges were on the inside of the rails, as they usually are, if the car ran on a curve, the flange of the outside wheel *F* would impinge against the rail, and the resistance thus encountered would tend to push that wheel backward, and thus cause the axle to move about the pivot *A* in a reverse direction to a radial position. For this reason, in the Hunt system, the flanges of the wheels are placed on the *outside* instead of the inside of the rails. With this arrangement, when the car, fig. 2, running on the straight track, reaches the curve, the flange of the wheel *B* strikes the rail at *C*. The pressure against the flange thus tends to force the wheel *B* backward into a radial position on the curve. At the same time the outer wheel runs on its flange—the outside rail of curves being of a special form for that purpose—and the larger diameter of the flange keeps the axle in a radial position during the rest of the passage of the curve. The treads of the wheels are coned, being larger on the inside than on the outside. As

Fig. 24.

there is a play of 1 in. between the flanges of the wheels and the rail, the coning on the wheels causes the axles to adjust themselves exactly at right angles to the track at every point.

In the attempts which have heretofore been made to solve the mechanical problem of constructing cars to run around curves easily, the effort has usually been made to solve one of the difficulties only, and all of them have had the radical defect that the more perfectly they worked on the curves the more imperfectly they worked on the straight track, and as there is much more straight than curved track on most lines, the arrangements for saving friction usually caused a greater loss on the straight track than was saved on the curves.

To meet the various requirements, three different classes of railroads have been devised, all of them with a gauge of 21 in., measured on the outside of the rails, as shown in fig. 3. On roads designated as class *A*, the cars are intended to be moved by hand, and the loads vary from 1,000 to 3,000 lbs. The rails are of very light section. The curves are of 12 ft. radius or more, and the cars have no couplings nor brakes. Figs. 4–9 represent cars for different purposes used on this class of roads.

On class *B* roads the cars are intended to be handled by locomotives, horses, or men. The cars have couplings and brakes unless otherwise ordered, and the loads vary from 2 000 to 6,000 lbs. The curves are 12 ft. radius or more, and the rails are of heavier section.

Class *C* is the same as class *B*, excepting that the loads are 16,000 lbs. and the curves 30 ft. radius or more, and the rails are made to suit the work.

The problem of designing a locomotive for running on curves of 12 ft. radius, which at the same time would have adequate tractive capacity, was a difficult one. The Hunt Company has

Fig. 21.

sought a solution of it by adopting a double-truck locomotive, represented by fig. 10. This has two trucks, each provided with a pair of cylinders. Each truck is connected to the engine by a hollow center-pin, through which the steam is conducted to

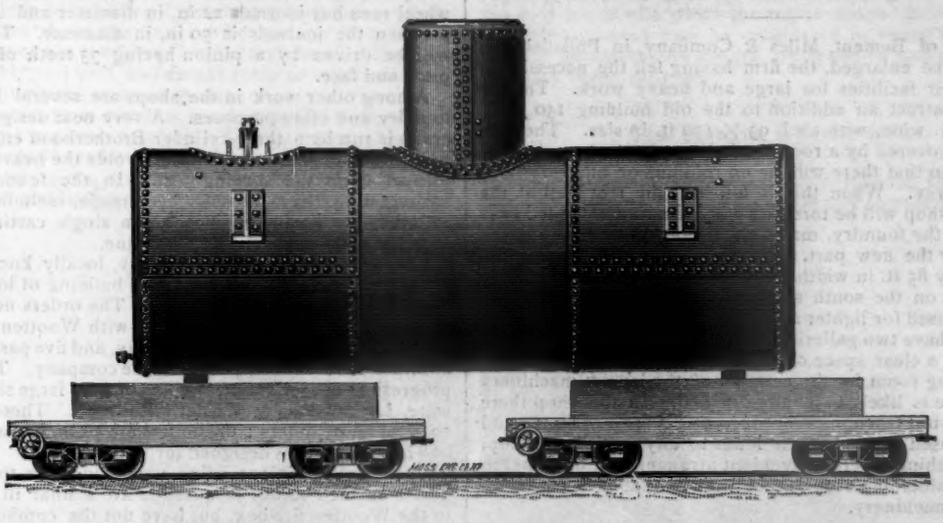


Fig. 22.

the cylinders by means of patented flexible joints, which adapt themselves to the necessary motion of the trucks in turning curves and in passing over inequalities of the track.

The wheels have the flanges on the outside of the rails, as

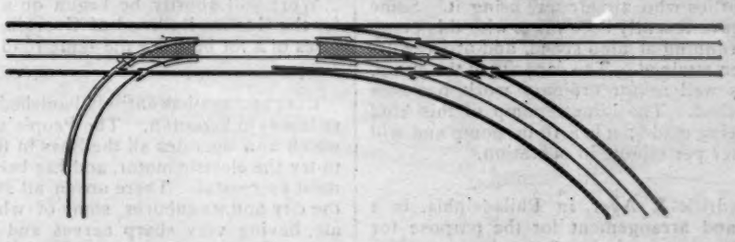


Fig. 23.

shown in fig. 24, and owing to the narrowness of the gauge, and to give greater accessibility to the journals, they and the frames are placed outside of the wheels, and disk cranks are connected to the axles outside of the frames, and the valve-gear is outside of the cranks. This makes all the parts very accessible and easy to inspect,

The main boxes for the axle bearings are made of bronze, and are turned on the outside to the form of part of a sphere which fits into a similar socket, and allows the bearing to turn, as the axles may be distorted in passing over uneven track, thus giving in all cases an evenly distributed load on the axle. If one wheel runs over an obstruction, the axles are thrown out of line with each other, as also are the crank-pins. The spherical bearings in this case turn slightly in the supporting boxes, and thus keep an even pressure on all parts of the axles and pins. In the engine described, the bearings of the crank-pins are so far outside of the wheels that the distortion of the journals would be a material objection. The bearings of the connecting and coupling-rods on the crank-pins are also made spherical in a like manner. This brings a perfectly square pressure on the bearings, no matter what the length of the bearing or the distortion of the axles may be, in running over an uneven track.

Professor Sweet's patented balanced valves and a form of "radial" valve-gear designed by Mr. Hunt are used.

Two kinds of boilers have been applied to these engines;

One, shown in fig. 10, is a modification of an ordinary locomotive boiler, but having a circular instead of the ordinary square fire-box. The other style of boiler has return flues, which brings the chimney out over the fire-box and cab, instead of at the front end.

The boilers are carried on independent plate-iron frames, and their arrangement gives plenty of room in the cab, and the space for the engineer is thus ample and convenient for him to see everything that is going on. If smoke is objectionable, anthracite coal, coke, or crude oil may be used for fuel.

Figs. 11–20 represent cross-sections showing different methods of laying the track. It will be seen that having the flanges outside of the rails gives an advantage from the fact that the ballast or other material forming the roadway may be laid between the rails flush with the top of their heads, which thus gives much better drainage and offers less obstruction to vehicles in and about works of different kinds. Frogs, switches, and crossings must, of course, be specially adapted for wheels with outside crossings.

As all the rolling stock for these roads is equally well adapted to run either way, no turn-tables are used.

The cars for carrying heavier loads, and to be hauled by locomotives, are made with trucks of the ordinary "diamond" pattern. The flanges of the wheels are, however, outside of the rails, as shown by figs 21 and 24. Fig. 22 shows the method of carrying heavy loads on two of the light cars.

In case it is desirable to connect a narrow-gauge system of road with one of the standard gauge, the rails of the former can be laid between those of the latter, as shown in fig. 23. Locomotives of either gauge can then move cars of their own or a different gauge on the double track.

The C. W. Hunt Company makes a specialty of the construction of this class of railroads and rolling stock, and may be addressed for information at their office at 45 Broadway, New York, or at their works at West New Brighton.

Some Scattering Notes.

THE shops of Bement, Miles & Company, in Philadelphia, are shortly to be enlarged, the firm having felt the necessity of increasing their facilities for large and heavy work. The design is to construct an addition to the old building 150 ft. in length by 85 ft. wide, with an L 93 × 100 ft. in size. The new shops will be covered by a roof carried on trusses spanning the entire width, so that there will be no columns or other obstructions in the way. When this is finished, the rear wall of the present main shop will be torn down and the roof extended over to the wall of the foundry, making that portion of the shop the same width as the new part. The main shop will be then 494 ft. in length by 85 ft. in width. In the new shop, the main portion will have on the south side two galleries 26 ft. in width, which can be used for lighter machinery and tools, and the wing or L will also have two galleries 30 ft. in width. This will leave in both shops a clear space of 60 ft. in width extending to the roof, and giving room for the erection of the largest machinery for which there is likely to be any demand. In this shop there will be two 30-ton traveling cranes, having a span of 60 ft., and these can be used to move their loads to any part of the shop, not only furnishing a very convenient arrangement, but making possible a considerable economy of time and labor in the building of heavy machinery.

THE Dow positive piston pump is meeting with very good success, the Kensington Engine Works in Philadelphia having many orders on hand for the pump, including a number of second and third orders from parties who are already using it. Some interesting experiments have recently been made with this pump to show its capacity for running at high speed, and 970 revolutions per minute have been attained. The capacity of the pump, as a high-duty pump as well as for ordinary work, has now been pretty well established. The largest pump of this kind yet constructed is now being made; it is a 16-in. pump and will deliver 1,800 gals. of water per minute in operation.

THE new shop of Pedrick & Ayer, in Philadelphia, is a model of good design and arrangement for the purpose for which it is used. In the center of the floor there are two clear openings extending to the roof and giving abundant room for work of almost any size or height, while around the shop, as a second story, is a wide gallery used for the lighter tools. The shop is well equipped with tools of all kinds, and is so arranged as to require the least possible amount of handling of materials. It is lighted with electric light, on the Mather system, each machine being provided with its own light, so arranged that it can be quickly moved to the point where it is most needed. A number of the universal milling machines are in construction to fill orders, and large machines of this class have recently been sold to the Delaware, Lackawanna & Western, the Union Pacific and the Kansas City, Fort Scott & Memphis shops. Indeed business is so active at present that the firm have been compelled to keep their old shop, using it as a repair shop. A convenient device noticed here was a cast-iron vise bench, having inside a closet with shelves for keeping tools. This bench is heavy enough to seat itself by its own weight, requiring no bolts to hold it in place, and at the same time can be readily moved to any part of the shop.

THE Dickson Manufacturing Company has two shops in Scranton. At the Penn Avenue shops a large amount of work is being done on general machinery, and on the floor of the main shop, which is arranged to take in work of almost any size, there is a great variety of large machinery in process of erection, including two 60-in. cylinders for a blowing engine, and other work of this class. The most striking object, however, is an enormous wheel for the Calumet & Hecla Company, which is probably the largest gear-wheel ever built. This is a sand-wheel, as it is called, intended to pump up tailings from the stamp mills, which cannot be handled with an ordinary pump owing to the large proportion of sand to the water. The wheel is 50 ft. in diameter on the face and 54 ft. outside the teeth, and will carry 448 steel buckets and will have a lifting capacity of 3,000,000 gals. of water and 2,000 tons of sand in 24 hours. The rim of the wheel is made of plates and angle-irons riveted together, and its general construction resembles that of a bicycle wheel, the connection between the rim and the hub being made by steel straining rods 3¼ in. in diameter. There are 18 of these rods and they are all in tension. The teeth are in segments bolted to the rim. The total number of teeth is 432; they are 4.70 in. pitch and 18 in. on the face, and have all been cut by a special machine designed by Mr. Broadbent, Superintendent of the shop. The shaft on which this wheel runs has journals 22 in. in diameter and 40 in. long, and between the journals is 30 in. in diameter. The great wheel will be driven by a pinion having 33 teeth of corresponding pitch and face.

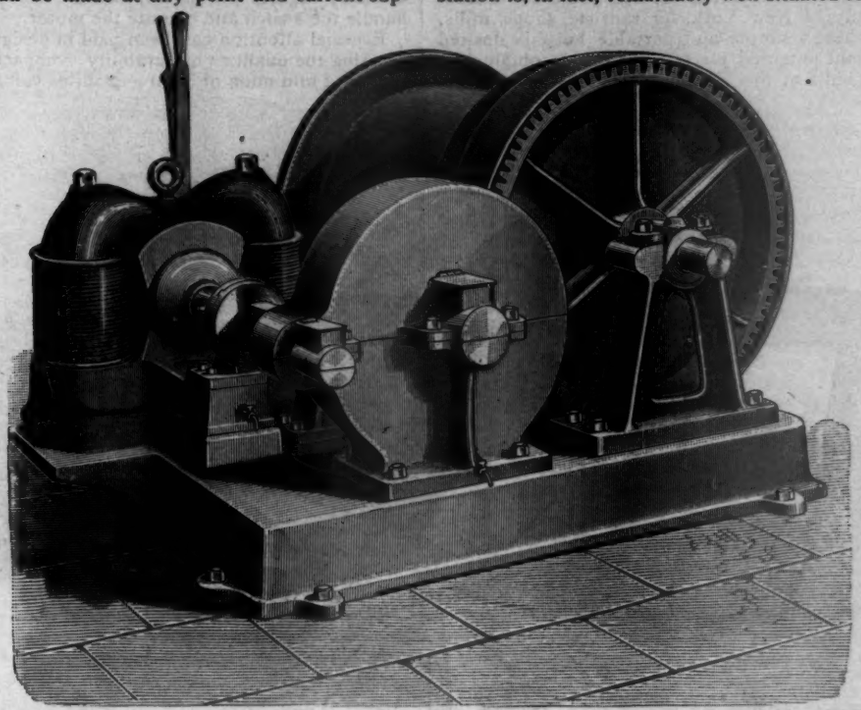
Among other work in the shops are several large cranes for foundry and other purposes. A very neat design for a foundry crane is run by a three-cylinder Brotherhood engine and is not only compact and powerful, but avoids the heavy strain usually thrown upon the turning-post. In the foundry some very large castings have recently been made, including some 90-in. cylinders for marine engines, and a single casting weighing 16 tons for a hydraulic riveting machine.

The other shops of this company, locally known as the Cliff Works, are devoted entirely to the building of locomotives, and are at present very full of work. The orders now on the floor include 15 consolidation engines, with Wootten boilers, for the Delaware & Hudson Canal Company, and five passenger engines, anthracite coal-burners, for the same company. There are also in progress 15 consolidation engines of very large size for the Delaware, Lackawanna & Western Railroad. These engines have 20 × 24 in. cylinders; the boilers are 58 in. in diameter of barrel and have fire-boxes designed for burning culm. The use of this fire-box, indeed, is extending very widely in the coal regions. Those on the engines in question are similar in general design to the Wootten fire-box, but have not the combustion chamber. A noticeable feature of these engines is not only the size of the boilers, but the fact that they are placed very high, the center of the boiler being at a height above the track which would have been considered inadmissible a few years ago.

Work will shortly be begun on a number of mogul engines for the Central Railroad of Georgia, these engines being duplicates of a lot built for the same road last year.

ELECTRICITY has entirely banished animal power on the street railroads in Scranton. The People's Street Railroad Company, which now operates all the lines in the city, was one of the first to try the electric motor, and has been, in operation, one of the most successful. There are in all 25 miles of street railroad in the city and its suburbs, some of which is very difficult to operate, having very sharp curves and grades as high as 10 per cent. The company has altogether 28 cars, 15 fitted with Sprague motors, 13 with the Thomson-Houston, and 3 with the Van de Poele. On these lines the number of passengers carried averages about 175,000 monthly, and on special occasions from 15,000 to 20,000 have been carried in a day. The ordinary duty of a car is about 100 miles per day. The system in use is the overhead wire, the power-wire being carried above the track

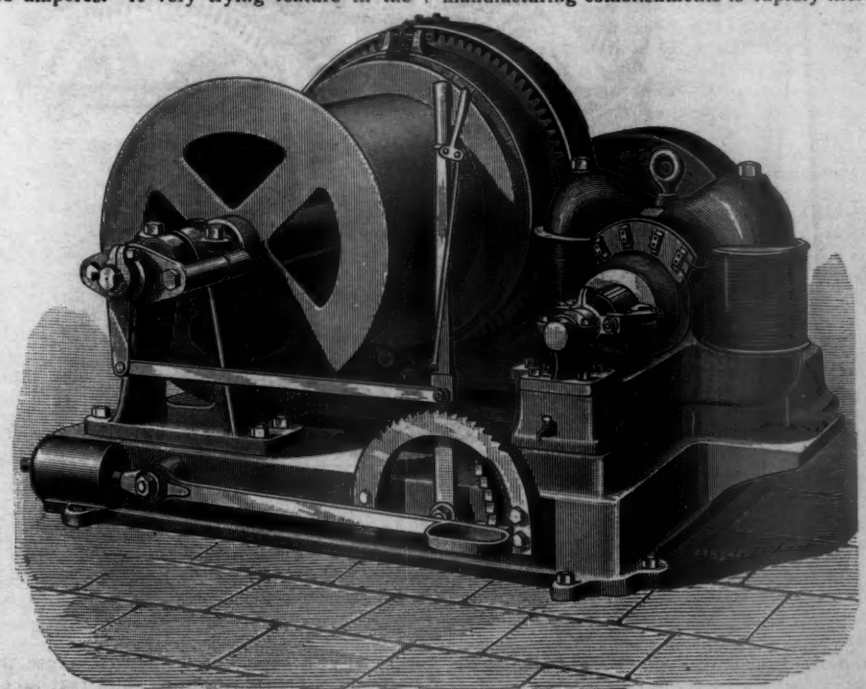
on brackets suspended from cross-wires stretched from poles on either side of the street. A feeder-wire is carried on the poles on one side, so that in case of a break in the main wire, a new connection can be made at any point and current supplied without delay. The connection between the power-wire and the car is made by a trolley carried on a long iron rod on top of the car, and the connection can be made or broken by a slight movement of the conductor's or driver's hand. The cars run very smoothly and well, and do not seem to experience any difficulty in climbing the steepest grades.



The power-house, from which power is supplied to the different lines, is very completely fitted up. There are three Armington & Sims engines of 125 H. P. each, which are kept constantly in service, and which run six No. 20 Edison dynamos, having a total power of 600 ampères. A very trying feature in the work of supplying power is the constant variation in the force expended. The indicators show that this may change abruptly from 10 to as high as 540 ampères, and that the changes are incessant. Steam is supplied to the engines by five tubular boilers 16 ft. long and 6 ft. diameter. There are two furnaces to each boiler, and the fuel used is culm or coal dust, which is supplied from a huge pile at the back of the power-house. The station is, in fact, remarkably well situated for securing a cheap supply of fuel, being in the immediate neighborhood of one of the coal mines with which the region around Scranton abounds. This electric road may be considered in every way a success, and the accidents and delays are fewer in number than on an ordinary horse railroad.

The Sprague Electric Hoist.

THE adoption of electric power in railroad shops and other manufacturing establishments is rapidly increasing, and nearly every day we hear of some new application of this kind for mill and shop purposes. A very short time ago electric motors were a novelty, but now they have been adopted by some of the leading railroads of the country for operating transfer-tables, turn-



tables, traveling cranes, and other machinery where a portable and compact power is required.

The accompanying illustrations show the motor for an electric hoist which has recently been built by the Sprague Electric Railway Motor Company of New York, for railroad shops, mills, and other places where a simple and portable hoist is desired and where a constant potential electric current is obtainable. The machine was built at the Edison Machine Works, Schenectady, N.Y., from designs made by engineers of wide experience in electric work.

The speed of the motor is controlled by an electric switch at one side, by means of which the speed can be varied at will by a single movement of the switch handle. Turning the handle to one notch will make the motor run slowly, to the second notch will increase the speed, and through the full number of notches will run it at full speed, while turning the handle in the opposite direction of rotation. The movements are very simple, so that no expert labor is required, and any one of ordinary engines will quickly become used to the hoist and can handle the switch and operate the motor.

Especial attention has been paid in designing the machine to securing the qualities of durability, compactness, ease of operation, and minimum of wear—qualities valuable in any case, but especially so should it be desired to use this hoist for mining purposes. The illustrations show that no extra room is taken up by the motor, but that everything is arranged to fit closely upon the iron base-frame.

The gears are all boxed in iron cases to protect them from dust, etc., but these cases are so made that they can be quickly removed should it be necessary to reach the working parts.

LARGE DOUBLE-CYLINDER POWER FEED SAND-PAPERING MACHINE.

The motor is designed to give the greatest possible power with the least weight, and has thus been made comparatively light, so that it can easily be carried from one part of the shop to another.

It is claimed that the efficiency of the electric motor when working up to its full load is over 90 per cent.; that is, more than nine-tenths of the energy which is delivered in the form of an electric current at the terminals of the motor is transformed into effective work at the armature pinion. This shows an extraordinary degree of efficiency.

The Sprague Company has completed this design after careful experiments, and it is to be followed by other special applications of electricity for shop purposes.

Manufactures.

Double-cylinder Sand-papering Machine.

THE accompanying illustration represents a machine of unusual size and capacity for putting the final finish on all kinds of wood used in the manufacture of cars, carriages, furniture, etc. As will be seen from the cut, the polishing cylinders are arranged below the bed of the machine; they run in long, self-oiling bearings, and are belted directly from one countershaft. The feeding-rolls are six in number, strongly and expansively geared. Directly above the cylinders there are also two pressure-rolls, which are raised with the upper feed-rolls by a hand-wheel and screw. These pressure-rolls can be adjusted with the feed-rolls, or independently, as may suit the work to be done. They are placed close to the cylinders, giving a positive feed. The polishing cylinders are easily accessible, being placed, as stated above, in the lower part of the frame, while the feed and pressure-rolls are mounted in the upper part. By removing the pintle at the end and turning the hand-wheel, the upper part can be raised to an angle of 45°, giving access to the cylinders for changing the sand-paper, or any other purposes. This arrangement is applied to both ends, so that one end can be raised and then the other, giving free access to both cylinders. Both cylinders have an independent vertical movement to suit the work to be done.

These machines will take any work up to 4 in. thick, and will finish all flat surfaces at one pass through the rollers. They are made in three sizes, 36 in., 42 in., and 48 in. wide. They are built entirely of iron and steel and weigh about 6,000 lbs. A countershaft, with hangers and pulleys, is furnished with each machine. The tight and loose pulleys are 16 × 6 in. and should make 650 revolutions.

This machine is built by the well-known works of J. A. Fay & Company, of Cincinnati.

Manufacturing Notes.

THE Bucyrus Foundry & Manufacturing Company, Bucyrus, O., is very busy, running the works night and day. Last year the company added a number of heavy tools to its plant, built a new erecting shop 180×45 ft. in size for heavy work, and fitted this shop with overhead traveling cranes and all the latest improvements. Its shipments included 48 steam shovels and 16 dredges, many of them very large machines, besides a number of railroad wrecking cars and other machinery. This company has now facilities for turning out a large amount of work.

RECENT contracts made by the Pond Engineering Company, St. Louis, Mo., are for a Holly duplex pump of 100,000 gals. capacity, with boiler, heater, etc., for the water-works at Seward, Neb.; a boiler and engine for the St. Louis Stamping Works; three 50 H. P. boilers completed, with shaking, grates, etc., for Kansas City; a Pond feed-pumping and receiver for the Security Building, Kansas City; a Tracy oil-filter, belting, etc., for the Vine Street Electric Railroad Line. The large pumping engine for the water-works at Taylorville, Ill., which this company is erecting, has been set up and tried. The Pond Company is also putting in the Eastman Hotel, Hot Springs, Ark., one of its largest sized feed-pumps and receivers, and is building a Hoppes live-steam purifier—for keeping boilers free from scale—of 150 H. P. size for Kansas City. Large orders for Sheffield grate-bars are reported.

AN order has recently been placed with W. S. Collins, Licensee, New York, for 72 burners of the Aerated Fuel Company's system, to fit up 36 of the large iron furnaces in the works of the John A. Roebling's Sons' Company, at Trenton, N. J. This order was given after a careful trial of the system. Several other important orders have also been received recently.

THE patents and other property of the Sewall Safety Car-Heating Company and the McElroy Car-Heating Company, together with other patents for car-heating appliances, are now the property of the Consolidated Car-Heating Company, which has been organized with a capital of $2,500,000. The new company, therefore, controls several distinct methods of heating which can be used either separately or in combination. It has established shops and depots in Albany and Chicago, and has its principal office in Albany, with branches in New York and Chicago. The officers of the new company are: President, Robert C. Pruyn; Vice-President, A. S. Hatch; Vice-President and Treasurer, William G. Rice; Secretary, Charles J. Peabody; General Manager, D. D. Sewall; Mechanical Superintendent, J. F. McElroy; Assistant General Manager, J. H. Sewall.

THE grand prize for the best wood-working machinery at the Paris Exposition has been awarded to J. A. Fay & Company, of Cincinnati, O., the well-known American manufacturers of that class of machinery.

THE Erie Car Works, Erie, Pa., are building a Goodwin dump car of the latest improved pattern, dumping either at the side or between the rails, as desired. The car is a four-wheeler, for carrying ore, coke, coal, etc.; it will carry 15 tons of ore in 20 ft. of extended train length. The axles have journals 3½ × 7 in. in size.

A NEW and extensive deposit of Franklinite iron ore has been discovered in Sussex County, N. J., near Franklin Furnace. It is expected that this deposit will prove as valuable as the original Franklin Mine. The property is owned by the Barnes Iron Bridge & Fence Company, of Philadelphia.

OBITUARY.

CAPTAIN GEORGE SKINNER, who died in Rome, Ga., October 1, aged 60 years, had served as superintendent on the Scioto Valley, the Canada Southern, and other roads. At the time of his death he was Superintendent of the Chattanooga, Rome & Columbus Railroad.

CHARLES A. ANDERSON, who died in New York, October 6, aged 83 years, was born in New York, and in early life was a civil engineer. He located a considerable part of the New York, New Haven & Hartford Railroad and was employed on other important works. Later in life he gave up engineering and became a broker in New York, where he was very successful. Mr. Anderson had considerable literary ability, and for a long time was a contributor to the New York *Evening Post*, and also assisted Mr. Bryant in other literary work.

JOHN CRERAR, who died in Chicago October 19, was widely known among railroad men as the founder and head of the great railroad supply house of Crerar, Adams & Company. He was born in Scotland, but came to this country when a boy, and began life in New York as a clerk, removing later to Chicago. He was largely interested in railroad and other enterprises, and at the time of his death was Vice-President of the Chicago & Alton Railroad Company, a director in the Illinois Steel Company, Pullman's Palace Car Company, and in several banking and other companies. Mr. Crerar leaves a large estate; he was never married.

SIR DANIEL GOOCH, who died in London, England, October 15, aged 73 years, was an eminent engineer. He was born in Northumberland and studied his profession at Newcastle, under Robert Stephenson, and in the large iron works of South Wales. For 27 years he held the position of Chief Locomotive Engineer to the Great Western Railway, and he served as Chairman of the Board of Directors of that company. He was one of the shareholders of the steamship *Great Eastern*. He was elected to Parliament in 1865, and about the same time he became Chairman of the Telegraph Construction & Maintenance Company, and a Director in the Anglo-American Cable Company. The dignity of a Baronet was conferred upon him after the laying of the Atlantic Cable, November 13, 1866. He was a distinguished Mason.

CAPTAIN WILLIAM R. JONES died at his residence in Braddock, Pa., September 26, from the results of an accident caused by the overflowing of a mass of melted metal in one of the furnaces of the Edgar Thomson Steel Works. Captain Jones was born in Luzerne County, Pa., in 1839, and at an early age entered the works of the Crane Iron Company at Catasauqua. He served in the Army during the war, and after its close en-

tered the service of the Cambria Iron Company as Assistant Chief Engineer. Some years later he was appointed Master Mechanic of the Edgar Thomson Steel Works, and later was promoted to be General Superintendent of the works, and held that position until the time of his death. He was considered high authority in the iron and steel business, and devised many improvements which were used in connection with the furnaces of his company. His inventions were a device for operating ladles in Bessemer process, improvements in loose couplings, fastenings for Bessemer converters, washers for ingot molds, hot beds for bending rails, apparatus for compressing ingots while casting ingot molds, cooling roll journals and shafts, feeding appliance for rolling mills, and many others. His latest invention, upon which a patent has not been issued, is a method for mixing metal taken from blast furnaces charging into two receiving tanks. Last year Captain Jones was appointed Consulting Engineer to Carnegie, Phipps & Co. He was a member of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the Engineers' Society of Western Pennsylvania, and the Iron & Steel Institute of Great Britain. He leaves a widow and two children.

PERSONALS.

H. R. TALCOTT has been appointed Chief Engineer of the Seattle, Lake Shore & Eastern Railroad.

A. J. PITKIN, Superintendent of the Schenectady Locomotive Works, has gone to Europe for a brief visit.

J. F. FANNING has been appointed Consulting Engineer of the St. Paul, Minneapolis & Manitoba Railroad.

ALEXANDER LAIRD has been appointed Master Mechanic of the Ohio River Railroad, with office at Parkersburg, W. Va.

C. C. WHEELER is appointed General Superintendent of the Atchison, Topeka & Santa Fé Railroad. He was recently on the Wisconsin Central.

PROFESSOR ARTHUR WINSLOW has been appointed State Geologist of Missouri, and is making arrangements to begin the survey of the city.

K. H. WADE has been appointed General Manager of the California lines of the Atchison, Topeka & Santa Fé. He was formerly on the Wabash Railroad.

FRANCIS COLLINGWOOD is now engaged in examining the Chemung River at Elmira, with a view to devising some plan for protecting the city against floods.

W. G. VAN BUSKIRK has been appointed Master Mechanic of the Terre Haute & Peoria Railroad, with office at Paris, Ill. He was recently on the Cleveland & Marietta Railroad.

GRANT WILKINS has resigned his position as Chief Engineer of the Atlanta Bridge & Axle Works. Mr. Wilkins has been connected with these works ever since they were started.

ANGUS SINCLAIR, Editor of the *National Car & Locomotive Builder*, sailed recently for Europe, where he intends to make some brief observations on the condition of railroad affairs abroad.

A. M. WAITT, recently with the Pullman Car Company, has been appointed Assistant General Master Car-Builder of the Lake Shore & Michigan Southern Railway, with office in Cleveland, O.

ROBERT GORDON, who is well known to many American engineers, has given up his connection with the Burmah Ruby Mining Company and has gone to Siam, where he has undertaken some engineering work.

LIEUTENANT HENRY H. BARROLL, U. S. N., was married at Danbury, Conn., October 3, to Marie Louise, daughter of Mr. T. Granville Hoyt of that place. Lieutenant Barroll is at present in charge of the Hydrographic Office at Norfolk, Va.

COMMODORE FRANCIS M. RAMSAY has been appointed Chief of the Bureau of Navigation in the Navy Department, to succeed REAR-ADMIRAL WALKER, who takes command of the new Squadron of Evolution, composed of the cruisers *Boston*, *Chicago*, *Atlanta*, and *Yorktown*. Commodore Ramsay has been for some time Commandant of the New York Navy-Yard, and it is understood that his successor in that position will be Rear-Admiral D. E. BRAINE.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting in New York, September 18, the Secretary announced the death of James H. Morley, a member and late Chief Engineer of the Missouri Pacific Railroad.

Written discussions of the paper on American Bridges read by Mr. Theodore Cooper, were presented by several members.

Mr. Cooper made a brief reply to these discussions.

Mr. H. R. Stanton exhibited a large number of photographs of the Grand Cañon of the Colorado River, where he has recently been engaged in making surveys for a railroad.

At the regular meeting in New York, October 2, a paper on Experiments Relating to Hydraulics of Fire Streams was read by John R. Freeman. It was announced that the ballots on the resolutions presented at the annual meeting had been canvassed, and that these resolutions were adopted. They are as follows:

"*Resolved*, That a committee of three members of this society be appointed by the President, to ascertain the best means of concentrating all obtainable information in such a manner as to secure useful results, and to report to the annual meeting of this society what further action, in their opinion, should be taken in the premises.

"*Resolved*, That a committee be appointed by the Board of Direction to be authorized and instructed to report to the society a set of Standard Rail Sections of weights beginning at 40 lbs., and advancing by increments of 5 lbs. to 100 lbs. per lineal yard.

"*Resolved*, That a committee of seven members of the society be appointed by the President to recommend uniform methods of testing the materials used in metallic structures.

"*Resolved*, That the same committee be requested to report such requirements for these materials as, in their judgment, may conduce to further improve the grade of such structures."

The following candidates were declared elected: *Members:* William A. Aiken, Mt. Vernon, O.; Ward Baldwin, Cincinnati, O.; S. H. Bodfish, Bernard R. Green, Washington, D. C.; Elias B. Noyes, Fort Edward, N. Y.; Charles O. Parker, Macon, Ga.; John C. Patterson, Poughkeepsie, N. Y.; Olaf R. Pihl, Cascade Rocks, Ore.; Anderson H. Tyson, Reading, Pa.; Alva M. Van Auken, Denver, Col.

Juniors: F. Rosenberg, Jersey City, N. J.; William W. Seitzinger, Tarrytown, N. Y.

At the regular meeting, October 16, Professor J. B. Johnson read a paper on Strength of Cast-iron—Tests and Specifications. The paper was long and elaborate, and contained an account of numerous experiments on this subject which the writer had made. The paper was discussed by Mr. Berg and Mr. J. A. Just.

The Board of Direction has received from the Nominating Committee the following list of members selected by the Committee as candidates for officers for the ensuing year. The Committee consists of Messrs. Stevenson Towle, O. E. Michaelis, Frederick H. Smith, Arthur Macy, and J. F. Wallace:

For President, William P. Shinn; for Vice-Presidents, Alphonse Fteley, Mendes Cohen; for Secretary and Librarian, John Bogart; for Treasurer, G. S. Greene, Jr.; for Directors, Charles B. Brush, Theodore Voorhees, Robert Van Buren, William Ludlow, William G. Curtis.

American Institute of Mining Engineers.—The fall meeting was held at Ottawa, Can., beginning October 1. At the evening session addresses of welcome were made by Sir John A. Macdonald and others, and were answered by members of the Association. Several notices of deceased members were read and about 50 new members were elected.

On the second day, the morning was occupied by visits to the great lumber mills in the neighborhood of Ottawa, and to the experimental farm maintained by the Government. In the evening a session was held at which papers were read on Mining and Natural Gas in Canada. In the evening a reception was given to the members by the citizens of Ottawa.

On the third day, the morning was given up to visiting the public buildings. Two business sessions were held at which a number of papers were read relating to Silver, Gold, and Copper Mining in Canada.

This concluded the business portion of the meeting. On the fourth day members went on an excursion to Little Rapids, returning in the evening, and on the fifth and last day the meeting broke up, some members going to Montreal, thence to the As-

bestos Mines in Eastern Quebec, while others went to the Mines at Sudbury.

Western Railway Club.—The first monthly meeting of the season was held in Chicago, September 17. The Secretary reported that the number of members had increased to 180. The following officers were elected for the coming year: President, John Hickey; Vice-Presidents, J. M. Barr and C. A. Schroyer; Treasurer, Allen Cooke; Secretary, W. D. Crosman.

Mr. W. H. Marshall read a carefully considered paper on Exhaust Pipes, Nozzles, and Steam Passages, which was pretty thoroughly discussed by the members present, many differences of opinion being developed in the discussion.

Following this there was a short discussion on Standard Axle-Box and Axle for 60,000-lb. cars.

Resolutions were adopted in favor of holding the Exposition of 1892 in Chicago.

Boston Society of Civil Engineers.—At the regular meeting of September 18, a Committee was appointed to confer with the Committee of the American Society of Civil Engineers on the proposed revision of the Constitution.

A paper on Mills and Mill Engineering was read by Mr. Edward Sawyer which was pretty thoroughly discussed by members and others present.

New England Water-Works Association.—The fall meeting of this Association was made delightful socially by an excursion to the White Mountains. The party included members and their friends, with ladies, and numbered about 60. It left Boston Saturday morning, September 28, took dinner at Plymouth, and got to the Crawford House in the Mountains in time for tea. Sunday was passed here enjoying the famous scenery, with a carriage ride to the summit of Mount Willard for the event of the day, and, indeed, one of the most enjoyable features of the trip. The party went on Monday morning through the great Crawford Notch to North Conway, from which place carriage rides were taken in the vicinity through the forenoon. After dinner the train was taken for Boston, and the party arrived there in the evening.

Connecticut Civil Engineers' & Surveyors' Association.—At the summer meeting in New Haven, there was a large attendance. The Committee on Water-works was requested to procure such records of Rainfall as may be valuable for the use of the Association. The Committee on Rain-gauges reported that 20 self-registering gauges were now in use at different signal stations. It was ordered that a committee be appointed to examine the laws of Connecticut in relation to Dams and Reservoirs and to report what new legislation may be needed.

Papers were read on Earth Dams, by Henry W. Ayres; on Accuracy in Measurements in Ordinary Surveys, by F. W. Whitlock; and on the New Haven Reservoir and Dam, by L. A. Taylor.

After the meeting the members visited the City Engineer's Office and examined the plans of the public buildings and works.

Engineers' Club of Philadelphia.—At the first regular meeting of the season, in Philadelphia, October 5, the Secretary presented a letter from Mr. Conway B. Hunt explaining the postponement, to next meeting, of his paper upon Repairing a Bridge Pier's Foundation.

Mr. George N. Bell presented a paper upon the Development of Suburban Property, in which it is clearly shown that this cannot be done to the best advantage without the assistance of systematic and intelligent engineering and landscape gardening. The paper and kindred subjects were discussed by Professor Arthur Beardsley and Messrs. T. M. Cleeman and Howard Murphy.

Franklin Institute.—The programme of the lecture season for the winter has been issued, and includes a great variety of subjects. Those announced for the present month are: November 4, the Proposed Isthmus Canal Routes, by Admiral Ammen; November 8, Municipal Engineering, by Professor Lewis M. Haupt; November 11, Stereo-Chemistry, by Professor Ira Remsen; November 15, Aeronautics, by Professor W. L. C. Stevens; November 18, Natural History in Schools, by Dr. H. Hensoldt; November 22, Work, Waste and Wages, by Mr. C. H. Clarke; November 25, The Development of Railroad Signaling, by Professor C. H. Koyl; November 29, Canada, by Mr. C. J. Hexamer.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, September 17, the subject for consideration was the appointment of a Committee to meet the Committee of the American Society of Civil Engineers to discuss the proposition made in relation to the co-operation or union of the different engineering societies. This called out a long discussion, in which many members took part, and resulted in the passage of a resolution directing the appointment of such a Committee. The Chairman named as members W. L. Scaife, J. W. Langley, and Thomas P. Roberts.

After this matter had been disposed of, there was a short informal discussion on the impurities in the water of the rivers near Pittsburgh, most of which resulted from the mine water, which is pumped from the mines and runs into the rivers. It was also stated that there are, especially in the Allegheny, many submerged springs, which is probably the case in a great number of rivers.

Engineers' Club of Cincinnati.—At the fourteenth regular meeting of the Club Estus T. Flynn and Charles L. Jungerman were elected to membership.

The subject for discussion was on the cause of and the best means for preventing Creeping of Rails in the Track on Bridges and Viaducts, and was suggested by the trouble being had from that source in the tracks of the Chesapeake & Ohio Railroad bridge at Cincinnati, where the rails are found to be moving from one to three inches per day.

Engineers' Club of St. Louis.—At the regular meeting, October 9, H. M. Kebby was elected a member.

President Meier presented a discussion on a new tractor recently invented by H. L. Van Zile, of Albany, N. Y., which, it was claimed, rendered it possible to make the total power of the machine available for traction. A model of this arrangement had worked very successfully. This was discussed by Messrs. Moore and Gale who spoke of the advantages of such a motor for street railroad work, and also of the similarity in design to the Fell system which had been used in Switzerland.

Mr. C. H. Sharman presented some reminiscences of the construction of the Union Pacific Railroad, in which he took an active part.

Denver Society of Civil Engineers and Architects.—At the regular meeting, October 8, Mr. Jackson, Building Inspector of Denver, read the larger portion of the new ordinance relating to the construction of buildings. The ordinance has now passed the Council and is waiting the passage of the supervisors to become a law. Among the main points covered are the division of the city into two fire districts, one covering the business portion of the city and the other the residence. Parties must defend their foundations to a depth of 10 ft. 6 in. on property lines; foundations for residences must be at least 2 ft. 6 in. deep; 90 days are allowed for the use of one-third of the street in front of property; no business wall in blocks is to end in less than a 13-in. wall; no wooden posts in business blocks over 20 ft. high; all tenement-houses, flats, and stores to be provided with scuttle in roof fastened inside, but not locked. The Society indorsed the ordinance and recommended an additional one regulating the manufacture and quality of brick, as much poor brick is now being used.

General Time Convention.—The fall meeting was held in New York, October 9, 60 roads being represented. The Executive Committee reported that there were in the Association 176 companies operating 120,891 miles of railroad.

The Committee on Car Service was made a Standing Committee, to consist of nine members, to serve for three years, three members to be elected each year. It was decided to appoint a Committee on Safety Appliances, to consider devices for power-brakes, couplers, switches, and signals, and apparatus for heating and lighting cars.

The Committee on Standard Code of Signals reported that during the last half year the Code has been adopted by 15 companies operating 13,135 miles of railroad. There are now 79 companies operating 52,267 miles of railroad which have fully adopted the Code.

The date for the adoption of the Mixed Mileage and Per Diem System of paying for car service, which had been fixed for January 1, 1890, was reconsidered, and the subject will come up for further consideration at the next meeting of the Convention in April.

The Committee on Car Service reported a plan for the organization of Car Service Associations, and also presented forms to be used in conducting the work. This report was approved, but the vote at the spring meeting, which fixed November 1 as

the date for these associations to begin work, was reconsidered and each road was recommended to put the system in operation as soon as possible.

American Society of Railroad Superintendents.—The 18th meeting was held in New York, October 7; 14 new members were elected. The Committee on Headquarters reported that it was not expedient to procure permanent rooms for the Association, believing it best to hold the meetings in different places.

Professor C. H. Koyl read a paper on Signals, describing his new semaphore.

The Committee on Roadway presented a report, the subjects treated in which were Rails and Fastenings, Metal Ties, Signals and Safety Appliances. Several patterns of semaphore signals were referred to, and attention was called to the system of guard-rails for bridges adopted on the Michigan Central. The Committee recommended that the prize offered for the best paper on track-work be awarded to the paper signed "Thistle."

Mr. L. W. Palmer read a paper on Terminal Charges which called out much discussion.

President Gadsden called attention to the merits of the weighted switch lever in use on many Southern roads.

The new Constitution proposed at the last meeting was discussed and finally adopted with some slight amendments. One of these amendments changes the name from the Association of North American Railroad Superintendents to that given above. A Committee was appointed to revise the by-laws and report at the next meeting.

Master Car-Builders' Association.—The Secretary, Mr. John W. Cloud, has issued from his office in Buffalo a circular giving the result of the questions recently submitted to letter-ballot. These questions, with the results of the ballots, are as follows:

1. Journal Box Lid: The Fletcher lid is adopted, but the special form of lid submitted failed to receive the necessary number of votes and is rejected.

2. The form of specification and guarantee for cast-iron car-wheels is adopted, both receiving largely over the required number of votes.

3. The axle for 60,000-lbs. cars, as submitted, is adopted. This axle has a journal $4\frac{1}{2} \times 8$ in. in size, and is 7 ft. $\frac{1}{4}$ in. over all, and 6 ft. 3 in. between centers of journals.

4. Brake-Gear for Air-Brake Cars: The standard, as submitted to ballot, is adopted in all particulars. This standard gives the maximum train-pipe pressure at 70 lbs.; the brake power exerted on all freight cars to be 70 per cent. of their light weight, and the brake beams to be required to stand a stress of 7,500 lbs., with a maximum deflection of $\frac{1}{16}$ in. The present standard brake-shoe to be maintained.

5. Draw-Bars and Carrier Irons for Standard Coupler: The standard submitted under this head was also adopted by a considerable majority. These standards are a draw-bar 30 in. long; draw-bar 28 in. long for repairs; size at neck 5 in. square; carrier-irons $5\frac{1}{2} \times 5\frac{1}{2}$ in.

It may be noted that these standards were accepted by unusually large votes, the number cast being considerable, and the majority given being large in almost all cases and unexpectedly large in the case of the standard axle.

New England Railroad Club.—At the regular meeting in Boston, October 9, the subject for discussion was Permanent Way and Rolling Stock and their Relation to each other. The discussion was opened by Mr. Lauder, who spoke at considerable length, and who was followed by Mr. Ellis, Secretary of the New England Roadmasters' Association, and by Messrs. Bishop, Clarke, Whitney, and others.

It was announced that the subject for the next meeting would be Journals and Journal Bearings.

Western Railway Club.—At the regular meeting in Chicago, October 15, the President read a short paper setting forth the objects of the Club, the advantages already secured, and those to be hoped for.

Mr. D. S. Barnes read a paper on Compound Locomotives, which was discussed by Messrs. Rhodes, Gibbs, Crossman, and others.

Mr. H. D. Sargent presented a paper on Brake-Shoes.

Northwest Railroad Club.—At the regular meeting in Minneapolis, October 5, it was decided to postpone the discussion on Wheels which had been announced for this meeting, until November. Mr. T. A. Griffin, President of the Griffin Wheel & Foundry Company of Chicago, was present, however, and gave a very interesting talk on the Manufacture of Car-Wheels, explaining the different processes adopted and the results obtained. He also spoke at considerable length on the use of contracting chills and on the advantages of balancing wheels.

American Forestry Congress.—The Eighth Annual Meeting began in Philadelphia, October 16, the opening address being made by Hon. Carl Schurz. At the first session a long and interesting paper on Methods of Forestry Reform was read by Mr. Bernard Fernow, Chief of the Forestry Division of the Department of Agriculture. This was followed by a paper on Forestry Legislation in New York, by Doctor H. M. Jarchow, which gave an interesting statement of the methods pursued in that State.

On the third day this paper was discussed by the Congress. Other papers read were one on Economy in Consumption of Timber for Railroads, by Mr. E. E. R. Trataman, and one on Government Forest Reserves in the West, by Mr. E. T. Ensign.

Resolutions were adopted urging upon the Government the establishment of a Commission for the preservation of the forests, on the public lands, and other measures for the encouragement of forestry.

International Marine Conference.—This Conference began its sessions in Washington, October 16, delegations being present from all the principal maritime nations of the world. Admiral Franklin, U. S. N., was chosen to preside over the Conference; Lieutenant Cottman, U. S. N., was chosen Secretary, with Assistant Secretaries from the English, French, and German delegations.

The Conference was expected to continue in session for some time. The programme, which has all been published in our columns, is an extensive one, but it is hardly probable that it will all be acted upon within the time allowed, especially as the instructions of the English Delegates were to confine the discussions as far as possible to marine signals and illustrations on the draft of vessels. The signals, however, were the principal point to be considered.

NOTES AND NEWS.

Making Coal Smokeless.—The *English Mechanic* says: "An invention which should be of considerable importance from a health point of view, was exhibited the other day at Willis's Rooms, St. James's. It consists in the application of some preparation to coal, by which the constituents are said to be concentrated and hardened. In practice the coal is steeped in the solution, and the fuel can be used either wet or dry. Two large fires were shown at the demonstration, one being made with coal in its normal condition, and the other with the treated coal. The difference was manifest, the chemicalized coal giving off but a very trifling amount of smoke, while a good blazing fire was maintained. The treatment of the coal is said to cost 6*d.* per ton, every expense included. The invention is being introduced by the Smoke Abatement & Fuel-Saving Corporation. It is proposed that the coal shall be treated in coal merchants' yards, ready for delivery to the consumer."

Killing by Electricity.—At a recent meeting of the Paris Academy of Sciences a paper by Mr. Edison on the application of electricity in place of hanging as a capital punishment was read. Mr. Edison compared the effects of the continuous currents with those of the alternating currents, and gave the preference to the latter, as he believes that they will cause death without any pain whatever. He described some experiments which he had performed on several of his own workmen. To a question that was put to him, as to what time it would take to consume a body, Mr. Edison replied that the body would not be consumed, but that its temperature would only be raised by three or four degrees, and that the body would then remain as if mummified. Mr. Edison concluded his communication with the expression that death by electricity may be produced instantaneously and without pain. Mr. Edison's paper was referred to the sections of physics and of medicine, and M. Marcel Desprez, the eminent electrician, is to draw up a report on the subject.

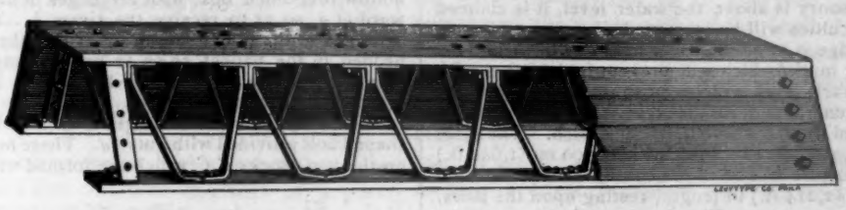
The Indian Survey Department.—A resolution by the Government on the General Report of the Survey Department for the year 1887–88 is issued. It states that the Department was under the direction of Colonel Thuillier throughout the year, and the Report, which presents a record of varied and useful work in survey and exploration, indicates that the De-

partment continues to be maintained in a state of high efficiency. Field operations were prosecuted by 26 parties; and geographical surveys and explorations have been carried out vigorously in Upper Burmah, with the result that triangulation has been extended over an area of 2,300 square miles, while nearly 21,000 square miles have been surveyed and mapped on the ¼-in. scale. The survey officers who accompanied the Hukong Valley and Black Mountain expeditions mapped large areas in comparatively unknown country; and a reconnaissance along the Nepaul border has supplied a rough basis for a more accurate and detailed survey of the northern frontier when opportunity offers. Interesting additional information regarding Bhutan and Thibet has been supplied by native travelers trained by the Survey Department, and new topographical maps, covering 15,673 square miles, have been constructed. The greater part of the available survey force is now devoted to work designed to combine the requirements of revenue administration with the demands of cartography. Taking the cadastral and traverse surveys together, the area covered during the year was upward of 25,000 square miles. The Resolution says that these extensive operations will aid materially in securing a punctual assessment of large tracts of country in which the settlement engagements are about to expire, and the Government of India desires to record its appreciation of the cordiality and zeal with which the Survey Department has lent itself to carrying out the programme imposed upon it by pressing fiscal and administrative considerations in this important section of its duties. The Surveyor-General draws attention to the difficulty of providing officers to superintend the various field operations and the necessity for further recruitment in view of the large number of prospective retirements. These matters are now under the separate consideration of the Government of India.—*The Indian Engineer.*

Testing the Verticality of the Eiffel Tower.—In the erection of the upper portion of the Eiffel Tower, it was found that plumb-lines could not be trusted, owing to the vibration caused by air-currents. It was, therefore, decided to have recourse to the theodolite, and to determine by its aid whether the central lines of the four faces were at all points in the principal planes of the tower. By principal planes is meant the vertical projections along two lines at right angles intersecting in the center of the plan of the tower. On account of the difficulty of marking the central points on the tower, this method of testing its verticality was not found applicable. The difficulty was, however, obviated by sighting to the centers of the faces, points which, as a rule, have a distinctive character, instead of to marked central points. If the theodolite is so placed that when its telescope is rotated, the center of the cross-wires coincides with two points in the horizontal plane of the line of section, the vertical wire will cut the tower in a line following the direction of the principal plane. The testing of the verticality of the tower then consists merely in ascertaining whether the central line of the face absolutely coincides with the determination of the vertical plane. This is a very simple operation, but one susceptible of very great precision. If the observation is made on the four faces of the tower, and the coincidences of the two lines are found to be exact, it necessarily follows that the axis of the tower is absolutely vertical. For the test to be conclusive, the theodolite must, at each observation, be set up with great accuracy in each one of the principal planes. In this manner the verification of the verticality of the tower was actually effected, the results obtained being perfectly satisfactory.—*M. E. Thuasne, in Nouvelles Annales de la Construction.*

Progressive Pressure Trials in Locomotives.—Mr. Dugald Drummond, Locomotive Engineer of the Caledonian Railway Company, is at the present time conducting some very interesting experiments, having for their object the determination of the effect of increasing steam pressures on locomotive economy. As is well known, Mr. Drummond believes that a non-compounded locomotive engine, working at the same pressure as a compound, is more economical than the compound engine, and the experiments now in progress are to thoroughly test economy by progressive pressures. For two or three weeks past he has been running an engine under steam of greater pressure than the standard, taking indicator cards and other data of the working, and the results obtained have induced him to make a series of progressive pressure trials to investigate the whole subject. He has secured six recently constructed non-compound locomotives of the ordinary type. In all respects they are alike, and they are driven by thoroughly capable men. These engines he purposes putting on the Carlisle and Aberdeen trains, a route favorable for such experiments, as the speeds are variable, the maximum being over 60 miles an hour; and the total distance is 249 miles. The only respect in which they will differ the one from the other will be in the working pressure. Two of them will be worked at 150 lbs. per square inch, two others to 175 lbs., and the remaining pair to 200 lbs. The advantage of duplication is obvious. Not only will cards be taken, but the coal consumption will be carefully noted, as well as revolutions, speed, and every other matter of interest, with grades, loads, and atmospheric conditions. The results of these trials will be of high interest and value.—*London Engineering.*

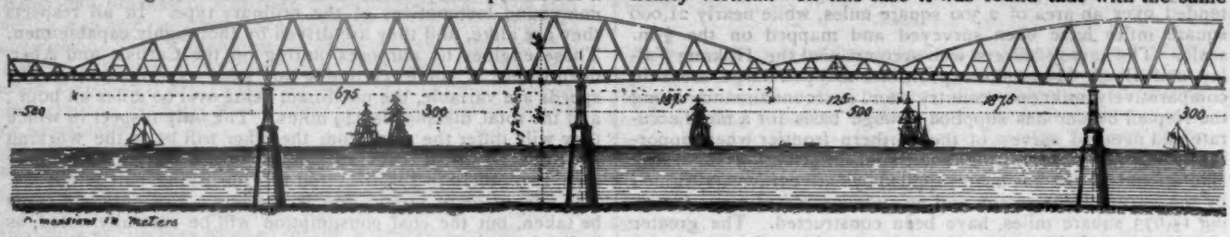
A New Iron Culvert.—The accompanying illustrations show a new design for an iron culvert for railroad and highway bridges which presents many advantages, as will readily be seen. Its construction will be easily understood from the engravings. The foundation consists of two wrought-iron sills the same length as the culvert, which form the base pieces upon which rest the girders or trusses, which rise to the desired height. To these trusses the planks or iron sheets forming the top and side-coverings are fastened. The girders are arranged in pairs inclining toward each other, the top horizontal portions being fastened together; at the bottom they are securely bolted or riveted to the sills. The top for highway culverts is generally covered with plank, but for railroad culverts where there would be some depth of earth over the culvert, iron would be used; the sides may be covered with iron or plank as preferred, but iron sides are considered the best.



In putting the culvert in, trenches are dug on each side of the stream, in the same way as for the first course of a stone foundation, to a depth a little below the bed of the stream, and sufficient to secure a solid foundation for the sill pieces to rest upon. The iron sills are then set right down in the trenches, the earth filled in and rammed down well so as to make it solid like the rest of the road, and the bridge is then ready for use. The top may be on a level with the adjacent roadway, or may be placed below the level and covered over with the same kind of earth or dressing as forms the road-bed, according to the location.

The designers of this culvert claim that it is not only cheap, strong, and durable, but in case of heavy freshets, it is not likely to be destroyed, and even if the bank should be washed out entirely, the culvert will hold together and can be readily replaced. It is manufactured by the Barnes Iron Bridge & Fence Company, of Philadelphia.

Bridging the English Channel.—The French and English technical papers have been discussing for some time a plan proposed by M. Hersent and by MM. Schneider & Company, the owners of the great iron works at Creusot. This plan is for a



bridge to cross the English Channel and to carry a line of railroad from the English coast to that of France. At present it is, perhaps, unnecessary to discuss too closely the details of this scheme, and it may be sufficient to say briefly that it is proposed to found the piers on caissons sunk to the bottom of the Channel, which, it is said, does not present anywhere any serious obstacles to a proper foundation. The main difficulty will be not in finding a solid bottom, but in placing the caissons and beginning the masonry on account of the roughness of the sea. When once the masonry is above the water level, it is claimed that no serious difficulties will be presented.

The proposed bridge is to have a clear headway of 61 m. (200 ft.) above low-water mark, which will prevent interference with navigation. The track level will be 72 m. (236 ft.) above the water-level. The general plan for the arrangement of the superstructure is outlined in the accompanying sketch. The piers will be placed alternately 300 m. (984 ft.) and 500 m. (1,640 ft.) apart; the superstructure will be of the cantilever type, consisting of spans 675 m. (2,214 ft.) in length, resting upon the piers, which are placed 300 m. apart. The openings of 500 m. will be covered by the projecting portions, 187.5 m. (615 ft.) each, of the two cantilever spans and by a short span 125 m. (410 ft.) in length, connecting the two. The extreme depth of the trusses of the long span will be 65 m. (213 ft.). These dimensions may, of course, be somewhat altered, should the plan be actually carried out. The two trusses are to be inclined somewhat to the horizontal and are to be connected by a suitable system of cross-bracing.

The floor of the bridge is to consist of two lines of rails supported by four rows of longitudinal beams, which will be carried on a suitable system of cross-girders resting upon the lower chords of the bridge trusses. A foot-walk will be arranged on either side outside of the rails.

Whether this plan will be carried out is very uncertain. That it, or something resembling it, is feasible, does not seem to be doubted, and while the details are open to discussion and the general plan to amendments, the main objections brought up so far have been the cost of the work and the possible objections of a political and international kind, similar to those raised to the building of the Channel Tunnel. As the estimated cost of the proposed bridge is $170,000,000 there may well be some doubt as to whether it would be a profitable investment.

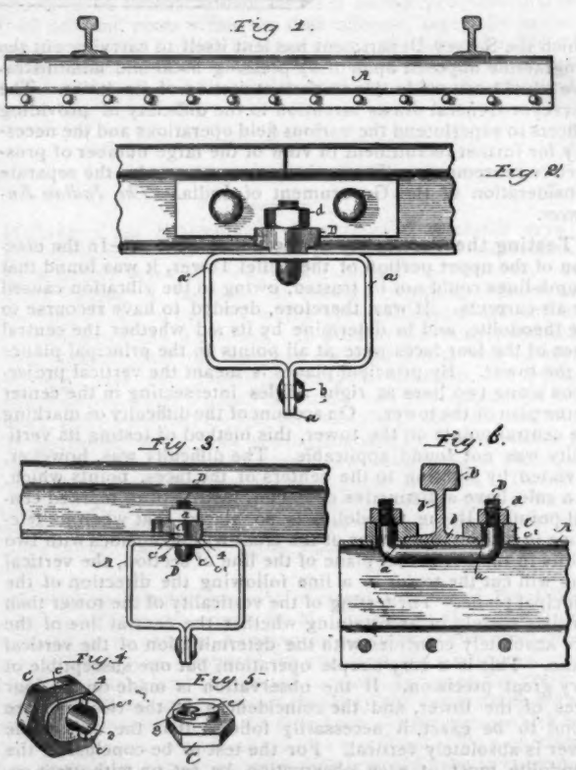
Foreign Gun-Notes.—Considerable dissatisfaction has been felt in Belgium for some time because orders for guns were sent to the Krupp Works in Germany. This feeling was so strongly expressed that the Government finally consented to test the ability of the Cockerill Company, whose bids had been rejected. Careful comparative tests of the material offered were made, and the final result was that the specimens submitted were declared superior to those from Krupp, and an order was given to the Cockerill Company for 62 guns of 12 cm. caliber.

The smokeless gunpowder which has been provisionally adopted for the German Army was tried in the recent fall manœuver with great success, and it is stated that the officers of the German General Staff are now willing to concede all the advantages claimed for it by the inventor. This smokeless powder, which was invented by an Austrian chemist, Dr. Falkenstein, was originally offered to the Austrian War Department and not approved.

Speed of Vessels in a Canal.—French naval engineers have been discussing the reduction in speed caused when the ship passes through a canal or narrow channel, and also the additional power required to move vessels in such a channel. Estimates of the reduction varied from one-half to one-third when based on theoretical calculations. Experiments actually carried on in the Suez Canal at points where the cross-section of the canal was about 4½ times the area of the immersed midship section of the steamer, show with the same number of revolutions of the screw, a reduction of about 54 per cent. in the speed of the vessel. Some further careful experiments were made with a model of the Corinth Canal in order to ascertain the resistance in this canal, the banks of which will be in many places nearly vertical. In this case it was found that with the same power, the reduction in speed would be from 46 to 58 per cent. from that made in the open sea.

A New Metallic Tie.—The accompanying illustrations show a new form proposed for metallic ties for railroads. Fig. 1 is a side elevation and fig. 2 an end view of the tie and rail; figs. 3, 4, 5, and 6 show the clamp or fastening which it is proposed to use with this tie. The body *A* of the tie is formed from a single plate of steel of suitable thickness, bent so as to form a hollow four-sided box, with the edges of the plate flanged outward at *a*, so as to receive the rivets *b*. These flanges *a* are arranged at the under side in order that they may be firmly imbedded in the ballast, so as to prevent any lateral movement. The corners are rounded or beveled as at *a'*, so as to give greater elasticity of action.

The clamp, as shown in figs. 3, 4, 5, and 6, consists of a U-shaped bolt provided with nuts *d d*. These nuts are screwed down on the jam-blocks *C C*, which are formed with a shoulder or off-



set, which when they are in position projects over the foot of the rail, while they are prevented from turning by the projection on the under side which fits into the hollow in the tie through which the ends of the bolt *D* pass. As will be seen from the illustrations, if the jam-blocks are turned in their proper position by a suitable wrench, the shoulders or off-sets *c c*, figs. 4 and 5, will bear against the rear edges of the holes in the tie, while the shoulders or extensions will bear upon the edges of the rail flange *b*. At the same time the upper part or body *C* of the jam-block will overlap the rail flange, and if the nuts *d d* be screwed down, the several parts will be securely held in position and the rail clamp firmly to the tie.

This tie is covered by Patent No. 411,959, and the clamp by Patent No. 411,958, both issued to Mr. Robert Forsyth, of Chicago, under date of October 1 last.